Mortality measures and uses

Data analysis and report writing workshop for civil registration and vital statistics in the Asia Pacific

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Data sources (general / cause specific)

- Vital registration systems
- Population censuses
  - Denominators, sometimes numerators (direct / indirect)
- Sample registration systems — India and China
- Demography and Health Surveys — child mortality estimates
- Population laboratories / epidemiological studies
- Hospital records / statistics
- Disease specific surveillance programs (MCH, cancers/HIV/TB)
- Police registers for injury deaths
- Others
Global availability of cause of death data from national vital registration systems around the year 2000

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Challenges in interpreting data at population level

- Voluminous datasets
- Main challenge lies in SUMMARIZING data to DESCRIBE population attributes and COMPARE across populations
Measures of mortality

- Absolute number of deaths
- Crude death rates
- Age specific death rates (perinatal/infant etc)
- Maternal mortality ratio
- Life expectancy; age-specific mortality risks
- Age-standardized death rates (total/cause-specific)
- Proportionate mortality ranks by cause, sex, age
- Years of Life Lost
- NCD mortality indicator
- Epidemiological measures – case fatality rates, relative risks, odds ratios
Age-specific death rates

Age specific death rate (ASDR)

\[
\text{ASDR} = \frac{\text{deaths in calendar year at age } x}{\text{mid year population at age } x} \times 1000
\]

ASDRs can be influenced by population age composition

These effects can be removed by standardization
Maternal and child mortality rates

Maternal mortality ratio
- Number of maternal deaths per 100,000 live births
- Life time risk of maternal mortality

Neonatal mortality rate
- Number of deaths of infants aged less than 1 month per 1,000 live births

Post-neonatal mortality rate
- Number of deaths of infants aged 1 to 11 months per 1,000 surviving infants at age 1 month

Infant mortality rate
- Number of deaths of infants aged less than 12 months per 1,000 live births

Child mortality rate
- Number of deaths of children aged 12 to 59 months per 1,000 surviving children at age 12 months

Under-five mortality rate
- Number of deaths of children aged 0 to 59 months per 1,000 live births
Mortality in early life

- Conception
- 28 weeks gestation
- Live birth
- One week after birth
- 28 days after birth
- One year
- Five years

- Miscarriage
- Fetal mortality
- Stillbirth
- Neonatal mortality
- Perinatal mortality
- Infant mortality
- Post neonatal mortality
- Child mortality
Life expectancies

Calculated by converting observed age specific mortality rates using a ‘life table’ to estimated probabilities of death (and survival) at different ages

Commonly used life table outputs include

- Life expectancy at birth \((e^0)\)
- Child mortality \((5q_0)\) – probability of dying before age 5 years
- Adult mortality \((45q_{15})\) probability of dying between 15 and 60 years
- Life expectancy at age 60 years \(e^{60}\)
- Mortality risk in elders \((20q_{60})\) – risk of dying between 60 and 80 years
## Life table

### Construction of an abridged life table

#### MALES

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<th>Deaths</th>
<th>(nM_x)</th>
<th>a</th>
<th>(nq_x)</th>
<th>(nP_x)</th>
<th>(L_x)</th>
<th>(d_x)</th>
<th>(L_x)</th>
<th>(T_x)</th>
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Total 34,346,564 233,276

(a) 5q0 0.04489
(b) 45q15 0.18023
## Proportional mortality - ranks

<table>
<thead>
<tr>
<th>Leading Causes of Death at All Ages</th>
<th>Males</th>
<th>Females</th>
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<tbody>
<tr>
<td>Ischaemic Heart Disease</td>
<td>13.3</td>
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<td>Cerebrovascular Disease</td>
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<td>Chronic Lower Respiratory Disease</td>
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<td>4.3</td>
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<td>Pneumonia</td>
<td>5.5</td>
<td>7.6</td>
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<td>Diabetes Mellitus</td>
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<td>Other Heart Diseases</td>
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<td>Cancer of Colon, Rectum and Anus</td>
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<td>1.3</td>
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<td>Hypertensive Diseases</td>
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<td>Trachea, Bronchus and Lung Cancer</td>
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<td>1.4</td>
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<td>Other Malignant Neoplasms</td>
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<tr>
<td>Falls</td>
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<td>1.8</td>
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<tr>
<td>Breast Cancer</td>
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<td>1.3</td>
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<tr>
<td>Symptoms and Ill-Defined Conditions</td>
<td>30.2</td>
<td>35.8</td>
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<td>Other Specified Causes</td>
<td>16.0</td>
<td>12.6</td>
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<tr>
<td><strong>Total</strong></td>
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<td>100.0</td>
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</table>
Years of Life Lost (YLLs)

- A measure of time lost due to premature death

- A major component of the international Burden of Disease indicator – Disability Adjusted Life Years

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

- In developing countries, YLLs account for 65-70% of DALYs, hence important to get the mortality component correct

- YLL calculated using Standard life expectancy

\[ e_x \] is the expectation of life at each age \( x \) based on ideal standard, facilitates comparison of YLLs across populations and over time

For Global Burden of Disease, the model life table used as standard (fem \( e^0 \) 82.5 years)

- In this indicator, deaths at all ages contribute to life lost due to premature death, and all deaths at same age from different populations contribute equally to the total burden
WHO NCD mortality Indicator definition

- Unconditional probability of dying between ages 30 and 70 from 4 major NCDs – CVDs, cancers, diabetes, and chronic respiratory diseases

- This indicator excludes potential for confounding across countries due to death from competing causes or different population age-structures

- Allows within country comparison over time to monitor 25% reduction, without confounding as mentioned above

- Age interval chosen because
  - NCD mortality starts rising at age 30
  - Mortality below 70 years is premature death in all populations aged 30 years
  - Cause-specific attribution above age 70 is riddled with uncertainty
Computation

- **Step 1**: calculate 5 year age-sp death rate – $5M_x$

  $$5M_x = \frac{\text{Total deaths from four NCD causes between exact age } x \text{ and exact age } x + 5}{\text{Total population between exact age } x \text{ and exact age } x + 5}$$

- **Step 2**: convert into probability of dying – $5q_x$

  $$5q_x = \frac{5M_x \times 5}{1 + \frac{5M_x \times 2.5}{5M_x \times 2}}$$

- **Step 3**: compound across target age interval

  $$40q_{30} = 1 - \prod_{x=30}^{65} (1 - 5q_x)$$
Uses of mortality data

- To assess population dynamics & change

At any time, Total Population size $P_t$ is:
$$P_t = P_0 + \text{births} - \text{deaths} + \text{Immig} - \text{Emig}$$

- Total mortality indicators (e.g. Life expectancy at birth; IMR) routinely used to IDENTIFY trends & differentials in socio-economic development
  (e.g. international; sub national; ethnic)

- Total and cause-specific mortality indicators used for health sector planning, evaluation, and research
Life Expectancy, 1950-2001, Selected Countries

- **Australia**
  - Males
  - Females

- **Japan**
  - Males
  - Females

- **Sweden**
  - Males
  - Females

- **United States of America**
  - Males
  - Females
Adult mortality (45q15) trend, 1950-2001

Australia

Japan

Sweden

United States of America
q5 Data Plots for the Top 20 Developing Countries: 5-8
Uses of cause of death data

- To study and EXPLAIN trends / differentials in overall mortality
- To guide priorities for resource allocation for intervention programs, biomedical and sociomedical research
- To monitor public health programs
- To provide clues for epidemiological research

MORTALITY STATISTICS EASIER TO ACQUIRE AND MORE RELIABLE THAN MORBIDITY— you only die once!
Trends in Mortality from *Ischaemic Heart Disease* 1950 – 2000 (age-standardized death rate at ages 60+)
Trends in Mortality from *Lung Cancer* 1950 – 2000 (age-standardized death rate at ages 60+)

![Graph showing trends in mortality from Lung Cancer from 1950 to 2000 for Australia, Japan, Sweden, and the USA. The x-axis represents years from 1950 to 2000, and the y-axis represents death rates per 100,000.](image-url)
Specific examples

- Risk factors: smoking & lung cancer
- Interventions: Road safety / speed control / seatbelt / drink driving
- Epidemiological research: monitoring cardiovascular mortality, diabetes mortality
- Screening programs: breast cancer mammography / pap smear
- Health services: DOTS treatment program; Maternal and child health care
Rear View Mirror- Trends in Cigarette Consumption and Lung Cancer Mortality in the US

Per capita cigarette consumption

Lung cancer death rates

Men

Lung cancer death rates

Women

Year

Number of cigarettes per capita

Lung cancer death rate per 100,000
Examples of time trends

Conclusions

- Obvious need for summarizing data

- Variety of summary indices

- Choice depends on data availability, and interpretational need

- Important to document methods, justify choices, and make rational inferences