Workshop on Demographic Measures and their Policy Implications: The Case of ECO Countries

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Organized by Civil Registration Organization and United Nations Population Fund

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Outline

• Basic demographic concepts
• Sources of demographic data
• Population growth, age-sex composition and marital status (marriage and divorce)
• Key demographic indicators
  – Fertility
  – Mortality
  – Migration
• MORTPAK for Windows: Version 4.3
  – Programmes and application
• Discussion and evaluation
DAY 2: MORNING SESSION
Mortality terminology

• **Mortality**: General term for death at all ages and from all causes.

• **Infant Mortality Rate**: Deaths that occur between birth and age 1.

• **Neonatal Mortality**: Death that occur during the first month of life (first 28 days).

• **Post-neonatal mortality**: Death that occur after the first 28 days but before age 1.
Mortality terminology

• Maternal Mortality: Deaths that occur to women during the reproductive process resulting from complications of pregnancy, childbirth, or the puerperium (immediately following childbirth).
• Morbidity; Illness, sickness, injuries, etc. and not to mortality
• Life span: Refers to the hypothetical, biologically-determined, limit to the length of life.
• Longevity: Usually measured by life expectancy (the number of additional years that the average person can expect to live, given the prevailing levels of mortality in the population).
Mortality Measures

Crude Death Rate (CDR)

The most common direct measure of mortality is the crude death rate, or the number of deaths per 1,000 population. It is calculated as the number of deaths occurring in a year divided by the population at midyear, times 1,000.

For example, the CDR for Chile in 1986 is obtained as follows:

\[
\frac{72,209 \text{ (deaths)}}{12,258,000 \text{ (population)}} \times 1,000 = 5.9
\]

There were 6 deaths per 1,000 population in Chile in 1986.

CDR is affected by age distribution of the population. Mortality varies by age and sex.
Comparison of Crude Death Rate by Countries, 2005-2010

<table>
<thead>
<tr>
<th>Country</th>
<th>Crude death rate</th>
<th>Life expectancy at birth</th>
</tr>
</thead>
<tbody>
<tr>
<td>More developed regions</td>
<td>10</td>
<td>77</td>
</tr>
<tr>
<td>Less developed regions</td>
<td>8</td>
<td>66</td>
</tr>
<tr>
<td>Islamic Republic of Iran</td>
<td>5</td>
<td>72</td>
</tr>
<tr>
<td>China</td>
<td>7</td>
<td>73</td>
</tr>
<tr>
<td>Canada</td>
<td>7</td>
<td>81</td>
</tr>
<tr>
<td>Australia</td>
<td>7</td>
<td>81</td>
</tr>
<tr>
<td>United States of America</td>
<td>8</td>
<td>78</td>
</tr>
<tr>
<td>France</td>
<td>9</td>
<td>81</td>
</tr>
<tr>
<td>Japan</td>
<td>9</td>
<td>83</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>10</td>
<td>80</td>
</tr>
<tr>
<td>Sweden</td>
<td>10</td>
<td>81</td>
</tr>
</tbody>
</table>

Age-Specific Death Rate (ASDR):

Number of deaths occurred to the population of specific age group during a calendar year divided by the mid-year population of the same age group in the same calendar year. The rate is commonly multiplied by 1,000 to represent as deaths per 1,000 population. ASDR is calculated for males and females separately.
**Age Specific Death Rates**

Number of deaths to people aged \( x \) years

\[
\text{ASDR} = \frac{d_x}{p_x} \cdot k
\]

Where (\( x \)) - age (age at last birthday)

\( k \) is usually 1,000

In symbols the ASDR can be denoted:

\[
m_x = \frac{d_x}{p_x}
\]

Where:

\( d_x \) - the deaths to people aged (\( x \)) and

\( p_x \) - the people aged (\( x \)) years.

Normally calculated by gender
Death rates in England and Wales 1991-95

Source: Office for National Statistics
Infant Mortality Rate (IMR)

When vital registration data are available, the infant mortality rate is usually calculated as the ratio of the number of infant deaths (under 1 year of age) occurred during one year to the number of live births occurred during the same year, times 1,000.

For example, the IMR for Chile in 1986 is obtained as follows:

\[
\frac{5,220 \text{ (infant deaths)}}{272,997 \text{ (live births)}} \times 1,000 = 19.1
\]

There were 19 infant deaths per 1,000 live births in Chile in 1986.
Trends of infant mortality rates, Iran, 1950 - 2000

Trend of under 5, infant and neonatal mortality rates, Iran, 1985-2000

Source: Iran Ministry of Health, Direct method using sample surveys data.
Maternal Mortality Ratio (MMR)

- The maternal mortality ratio is the number of women who die as a result of complications of pregnancy or childbearing in a given year per 100,000 live births in that year. It also includes deaths due to complications of spontaneous abortions.

Example: Maternal deaths in Russia in 1994 = 185 and total live births = 1,408,159.

There were 13.1 maternal deaths per 100,000 live births in Russia in 1994.

- This measure is sometimes referred to as the maternal mortality rate, which is calculated as the number of maternal deaths divided by the number of women of childbearing age in the population multiplied by 100,000.
Trend of maternal mortality ratio in Iran, 1974-1996

Source: Iran Ministry of Health, Direct method using Sample surveys data.
One of the most useful summary measures of the overall level of mortality of a population is the life expectancy at birth.
Life Table

Life table represents a comprehensive description of survival, from one age to the next, among a cohort of births under given schedule of age-specific death rate.

- Usually calculated separately for males and females because of the differences in mortality between males and females.

- Basic data needed for the construction of life table are: estimates of the mid-year population by age (usually five year age groups) and sex and the number of deaths during the year classified by age and sex.

- Complete life table and abridged life table.

- Provides a summary measure (expectation of life at birth) which is comparable across countries.
Steps for constructing life table:

**Step 1**: Calculate ASDR \((nM_x\) expressed as per person) and IMR for males and females, separately.

**Step 2**: Convert \(nM_x\) to \(nq_x\) using the formula

\[
q_x = \frac{2n \times M_x}{2 + (n \times M_x)}
\]

During this process we are converting the age-specific deaths rates (which are calculated using the mid-year population or the mid-point of the age interval to probabilities of dying \((q_x)\), which uses population at exact ages ‘x’.

**Step 3**: Calculate \(np_x\), which represents the probabilities of survival from age ‘x’ to ‘x+n’, using the following formula.

\[
p_x = 1 - q_x
\]
**Step 4:** Calculate ‘$l_x$’. Start with ‘$l_0$’ = 10,000 or 100,000 which is the cohort of births.

\[ l_{x+n} = l_x \times n p_x \]

$l_x$ is known as the survivorship function of the life table. It traces the number of people who survive to exact ages ‘x’ starting from a cohort of births ‘$l_0$’.

**Step 5:** Calculate $n d_x$, the number of deaths between ages ‘x’ and ‘x+n’, using the formula  
\[ n d_x = l_x - l_{x+n} \]

**Step 6:** Calculate $n L_x$, the number of person-years lived (equivalent to stationary population in the age group ‘x’ to ‘x+n’) between ages ‘x’ and ‘x+n’.

\[ n L_x = \frac{n (l_{x+n} + l_x)}{2} \]
Step 7: Calculate ‘$T_x$’, the total number of person-years lived above age ‘$x$’.

$$T_x = \sum nL_x \quad \text{(for all ages above age ‘$x$’)}$$

‘$T_0$’ is the total number of years lived by the cohort ‘$l_0$’

Step 8: Calculate ‘$e^0_x$’, the expectation of life at age ‘$x$’ as follows.

$$e^0_x = \frac{T_x}{l_x}$$

is the number of years aged ‘$x$’ is expected to live beyond age ‘$x$’ under the given conditions of mortality.
Calculation of Survival Ratios:

• Life table provides the main source of survival ratios used in making population projections.

• For example, a cohort of people aged 10-14 in the year 2000 will become 15-19 in the year 2005, naturally some of whom will die and others will survive.

• The proportion of people who will survive from one age (or age group) to the next age (age group) is called the survival ratio (which is different from the probabilities of survival $n p_x$ given in the life table).

• Survival ratio: $n S_{x, x+n} = \frac{n L_{x, x+n}}{n L_x}$ and $5 S_0 = \frac{5 L_0}{5 x I_0}$
Epidemiological transition

• “A long-term shift in health and disease patterns that has brought death rates down from very high levels in which people die young, primarily from communicable disease, to low levels with deaths concentrated among the elderly, who die from degenerative diseases” (Weeks 2002: 140).
Causes of death:
Infectious and parasitic diseases

- For much of human history, infectious diseases have been the major cause of death.
- Infectious and parasitic diseases are far less important as a cause of death in the US, Canada, and other developed societies in the past.
Causes of death: degenerative from chronic diseases

- Degeneration = biological deterioration of a body – chronic illnesses, non-communicable diseases, and degenerative disease.
- They are characterized by uncertain causes, multiple risk factors, a long latency period, functional impairment or disability, etc.
Products of social and economic environments

• Example: Suicide, car accidents, homicide, other types of accidents (Slips and is killed in bathtub, ...)

• Except for death caused by natural disaster
### Ten leading causes of death in the US 1900

<table>
<thead>
<tr>
<th>Cause</th>
<th>% of total deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong> Pneumonia-Influenza-Bronchitis</td>
<td><strong>14.4</strong></td>
</tr>
<tr>
<td><strong>2</strong> Tuberculosis</td>
<td><strong>11.3</strong></td>
</tr>
<tr>
<td><strong>3</strong> Diarrhea and enteritis</td>
<td><strong>8.1</strong></td>
</tr>
<tr>
<td><strong>4</strong> Heart Disease</td>
<td><strong>8.0</strong></td>
</tr>
<tr>
<td><strong>5</strong> Chronic nephritis</td>
<td><strong>4.7</strong></td>
</tr>
<tr>
<td><strong>6</strong> Accidents</td>
<td><strong>4.6</strong></td>
</tr>
<tr>
<td><strong>7</strong> Congestion and brain hemorrhage</td>
<td><strong>4.2</strong></td>
</tr>
<tr>
<td><strong>8</strong> Diseases of Early infancy</td>
<td><strong>4.2</strong></td>
</tr>
<tr>
<td><strong>9</strong> Cancer</td>
<td><strong>3.7</strong></td>
</tr>
<tr>
<td><strong>10</strong> Diphtheria</td>
<td><strong>2.3</strong></td>
</tr>
</tbody>
</table>
## Ten leading causes of death in the US 1930

<table>
<thead>
<tr>
<th>Cause</th>
<th>% of total deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Heart Disease</td>
<td>18.9</td>
</tr>
<tr>
<td>2 Pneumonia-Influenza-Bronchitis</td>
<td>9.4</td>
</tr>
<tr>
<td>3 Cancer</td>
<td>8.6</td>
</tr>
<tr>
<td>4 Nephritis</td>
<td>8.0</td>
</tr>
<tr>
<td>5 Cerebral hemorrhage</td>
<td>7.1</td>
</tr>
<tr>
<td>6 Tuberculosis</td>
<td>6.3</td>
</tr>
<tr>
<td>7 Diseases of Early infancy</td>
<td>4.4</td>
</tr>
<tr>
<td>8 Accidents, Suicide</td>
<td>3.1</td>
</tr>
<tr>
<td>9 Motor Vehicle accidents</td>
<td>2.4</td>
</tr>
<tr>
<td>10 Diarrhea and enteritis</td>
<td>2.3</td>
</tr>
<tr>
<td>Cause</td>
<td>% of total deaths</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Heart Disease</td>
<td>29.5</td>
</tr>
<tr>
<td>Cancer</td>
<td>22.9</td>
</tr>
<tr>
<td>Stroke</td>
<td>6.9</td>
</tr>
<tr>
<td>Chronic lower respiratory disease</td>
<td>5.1</td>
</tr>
<tr>
<td>Accidents</td>
<td>3.9</td>
</tr>
<tr>
<td>Diabetes</td>
<td>2.9</td>
</tr>
<tr>
<td>Influenza and Pneumonia</td>
<td>2.8</td>
</tr>
<tr>
<td>Alzheimer’s disease</td>
<td>2.0</td>
</tr>
<tr>
<td>Nephritis, nephrotic syndrome, and nephrosis</td>
<td>1.6</td>
</tr>
<tr>
<td>Septicemia</td>
<td>1.3</td>
</tr>
</tbody>
</table>
Historical mortality transition: key issues

- Timing and speed of the decline
- Causes of death responsible for the decline
- Explanations for the transition
- Age patterns of the decline
Comparison of mortality decline in Developed and Less Developed Countries

<table>
<thead>
<tr>
<th></th>
<th>DCs</th>
<th>LDCs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Timing and speed</strong></td>
<td>Around 1750 or a bit earlier (industrial revolution); gradual decline</td>
<td>After 1950s: very rapid decline = rapid population growth</td>
</tr>
<tr>
<td><strong>Causes of death</strong></td>
<td>Infectious parasitic diseases</td>
<td>Infectious and parasitic diseases</td>
</tr>
<tr>
<td><strong>Explanations</strong> for the</td>
<td>The early period of decline: economic development, improved condition of living and hygiene. The later period of decline: Advancement in medicine (especially vaccination for smallpox)</td>
<td>Medicine and knowledge on public health transferred from the West.</td>
</tr>
<tr>
<td><strong>Age pattern</strong> of the</td>
<td>Huge reduction in infant and child mortality. Now most deaths occur to people ages 60 and over</td>
<td>Reduction in infant and child mortality.</td>
</tr>
<tr>
<td><strong>Decline</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Distribution of deaths by cause of death and age, Iran, 2002

Distribution of deaths by cause and age among men in Iran, 2002

Distribution of deaths by cause and age among women in Iran, 2002

Distribution of deaths by accidents and age, 2002

Advantages of Civil Registration data on causes of death

• Data are current and provide dynamic picture of the vital events

• Full coverage of population

• Adding few variables would be less costly compared with other sources of data

• Achievements have been made in reducing IMR & MMR but further development would lead to more reduction
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