Recent Mortality Trends and Prospects: Hong Kong and Taiwan

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Introduction

• Current mortality in Hong Kong and Taiwan are quite low, and near the level of Japan, Sweden, and Switzerland.
• To examine the historical changes of the levels and rates of mortality in Hong Kong and Taiwan, and
• To project future mortality for Hong Kong and Taiwan.
Life expectancy at Birth in Taiwan
1906-2001

Female

Male
Life expectancy at Birth: HK and Taiwan, 1961-2001

Female, Hong Kong

Male, Hong Kong

Female, Taiwan

Male, Taiwan
Due to new birth registration system implemented in 1994, the infant mortality rates increased dramatically since 1995. The IMR were:

<table>
<thead>
<tr>
<th>Year</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>5.4</td>
</tr>
<tr>
<td>1992</td>
<td>5.6</td>
</tr>
<tr>
<td>1993</td>
<td>5.3</td>
</tr>
<tr>
<td>1994</td>
<td>5.7</td>
</tr>
<tr>
<td>1995</td>
<td>7.4</td>
</tr>
<tr>
<td>1996</td>
<td>7.5</td>
</tr>
<tr>
<td>1997</td>
<td>7.1</td>
</tr>
<tr>
<td>1998</td>
<td>7.1</td>
</tr>
<tr>
<td>1999</td>
<td>7.2</td>
</tr>
<tr>
<td>2000</td>
<td>7.0</td>
</tr>
<tr>
<td>2001</td>
<td>6.5</td>
</tr>
</tbody>
</table>
Life expectancy: $e_{65}^{HK}$ and Taiwan, 1961-2001
Life expectancy: $e_{85}^{HK}$ and Taiwan, 1961-2001
Probabilities of dying ($q_x$) Hong Kong, 1971-1999

(a) Male

(b) Female
Probabilities of dying ($q_x$) Taiwan, 1970-2001
Contribution of mortality changes at each age group to the total changes in $e_0$, Hong Kong, 1970-2001

Notes: A denotes age 0; B denotes childhood (Ages 1-4); C denotes late childhood (Ages 5-14); D denotes adulthood (Ages 15-49); E denotes late adulthood (Ages 50-64) and F denotes old ages at 65 and over.
Contribution of mortality changes at each age group to the total changes in $e_0$, Taiwan, 1970-2001

Notes: A denotes age 0; B denotes childhood (Ages 1-4); C denotes late childhood (Ages 5-14); D denotes adulthood (Ages 15-49); E denotes late adulthood (Ages 50-64) and F denotes old ages at 65 and over.
Mortality Trends in Taiwan, 1981-2000

Deaths and Death Rates, Taiwan Area, 1981-2000

Number of deaths

Death rate per 100,000 population

- 80 years and over
- 65-79 years old
- 0-64 years old
- Age-adjusted Death Rate
- Unadjusted death rates
The Changes in Death Rates by Leading Causes of Deaths, 1989-2000, Taiwan

Death Rate — Percent Change, by Leading Cause, 1989-2000

- All causes of death: 9.79%
- Malignant neoplasms: 50.73%
- Cerebrovascular diseases: -16.86%
- Heart diseases: -11.06%
- Accidents and adverse effects: -32.50%
- Diabetes mellitus: 120.32%
- Chronic liver diseases and cirrhosis: 31.43%
- Nephritis, nephrotic syndrome and nephrosis: 66.75%
- Pneumonia: 1.08%
- Suicide: 41.66%
- Bronchitis, emphysema and asthma: -43.30%
The Changes in Male Death Rates by Leading Causes of Deaths, 1989-2000, Taiwan

Death Rate — Percent Change, for Male, by Leading Cause, 1989-2000

- All causes of death: 12.38%
- Malignant neoplasms: 52.73%
- Cerebrovascular diseases: -9.99%
- Accidents and adverse effects: -32.57%
- Heart diseases: -3.42%
- Diabetes mellitus: 149.44%
- Chronic liver diseases and cirrhosis: 32.04%
- Pneumonia: 2.86%
- Nephritis, nephrotic syndrome and nephrosis: 67.90%
- Suicide: 53.04%
- Tuberculosis: -27.83%
### The Changes in Female Death Rates by Leading Causes of Deaths, 1989-2000, Taiwan

#### Death Rate — Percent Change, for Female, by Leading Cause, 1989-2000

<table>
<thead>
<tr>
<th>Cause</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>All causes of death</td>
<td>6.39</td>
</tr>
<tr>
<td>Malignant neoplasms</td>
<td>48.39</td>
</tr>
<tr>
<td>Cerebrovascular diseases</td>
<td>-24.88</td>
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<tr>
<td>Diabetes mellitus</td>
<td>99.02</td>
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<tr>
<td>Heart diseases</td>
<td>65.58</td>
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<tr>
<td>Accidents and adverse effects</td>
<td>32.22</td>
</tr>
<tr>
<td>Nephritis, nephrotic syndrome and nephrosis</td>
<td>-1.22</td>
</tr>
<tr>
<td>Chronic liver diseases and cirrhosis</td>
<td>24.16</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>-49.90</td>
</tr>
<tr>
<td>Suicide</td>
<td></td>
</tr>
<tr>
<td>Hypertensive diseases</td>
<td></td>
</tr>
</tbody>
</table>
The changes in Death Rates of Ages 65 and Older by Leading Causes, 1989-2000, Taiwan

Death Rate Among Persons 65 Years Old and Over — Percent Change, by Leading Cause, 1989-2000

- All causes
- Malignant neoplasms: -12.74%
- Cerebrovascular diseases: -37.36%
- Heart diseases: -34.90%
- Diabetes mellitus: 70.00%
- Nephritis, nephrotic syndrome and nephrosis: 44.18%
- Pneumonia: -16.72%
- Nephritis, nephrotic syndrome and nephrosis: -25.80%
- Chronic liver diseases and cirrhosis: -4.92%
- Hypertensive diseases: -63.95%
- Bronchitis, emphysema and asthma: -59.82%

Legend:
- Blue bars represent the percent change.
Death Rates of the Major Causes of Death of the Elderly by Sex in HK, 1961-1997

(a) Male

(b) Female

Legend:
- Malignant Neoplasms
- Pneumonia
- Nephritis, nephrotic syndrome and nephrosis
- Heart diseases
- Cerebrovascular disease
Proportionate Mortality of Major Causes of Death of the Elderly in HK, 1961-1997

Notes: A denotes malignant neoplasms; B denotes heart diseases; C denotes pneumonia; D denotes cerebrovascular disease; E denotes nephritis, nephrotic syndrome and nephrosis, and F denotes others.
Lee-Carter Model

• Lee and Carter (1992) proposed a simple **ARIMA model** to make a long-run probabilistic forecast for future mortality in the United States based on U.S. mortality of 1900-1989.

• Decomposing the time series of age-specific mortality changes to two parts: the **time component** which is variant over time and the **age component** which is invariant over time.

• The equation:  

$$\ln(m_x(t)) = a_x + b_x \times k(t) + \varepsilon_x(t)$$
Data

• Applying the instantaneous mortality rate at age x in year t, $\mu_x(t)$, and

• To derive $\mu_x(t)$ from official life tables (Hong Kong: 1971-1999, and Taiwan: 1970-2001)

• The Coale-Guo method, incorporating an assumption of a steady decrease in mortality at old-ages, was employed to obtain the instantaneous mortality rates for ages 85-100.
\( a_x \) is an average of age-specific mortality rates on the logarithmic scale. It describes the major trend of age pattern of mortality.
Modeling future $k'(t)$

- $k'(t)$ can be modeled separately for each sex by **ARIMA** models.
- **The best models** for both sexes that fitted the data are **ARIMA(0,1,0),**
  - HK - Male: $k'(t)-k'(t-1)=-2.6259+\varepsilon(t)$
  - HK - Female: $k'(t)-k'(t-1)=-2.7124+\varepsilon(t)$
  - Taiwan - Male: $k'(t)-k'(t-1)=-1.7253+\varepsilon(t)$
  - Taiwan - Female: $k'(t)-k'(t-1)=-2.4161+\varepsilon(t)$
Forecasted $k'(t)$ by sex and 95% percent confidence interval: Hong Kong

Female

Male
Forecasted $k'(t)$ by sex and 95% percent confidence interval: Taiwan
Forecasted $e_0$ by sex and 95% percent confidence intervals
Forecasted $e_{65}$ by sex and 95% percent confidence intervals
Forecasted $e_{85}$ by sex and 95% percent confidence intervals

- **Hong Kong, Female**
- **Taiwan, Female**
- **Hong Kong, Male**
- **Taiwan, Male**