Population

Births and deaths–fundamental concepts.

The **birth rate** or crude birth rate (P&B 41)

$$CBR = \frac{\text{number of births}}{\text{midyear population}} \times 1000.$$

The **death rate** or crude death rate (P&B 112).

$$CDR = \frac{\text{number of deaths}}{\text{midyear population}} \times 1000.$$

Deaths and births in China–Naughton (ch. 7) writing on modern history

China's recent population history contains two of the most remarkable episodes ever observed in a human population

*the famine that followed the Great Leap Forward ... the biggest population disaster of our time [more than 30 million died between 1958-61]

*the extraordinarily rapid reduction in birth rates during the 1970s... faster and more complete than any similar fertility decline elsewhere in the world.

The fall in population does not register in our 500 years of population history diagram which interpolated between 10 year totals and so indicated **no** fall.

But both developments can be seen in this figure

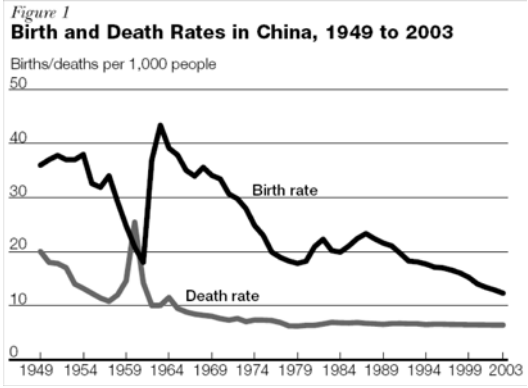

Figure 1of Riley (2004)

*The effects of the GLF can be seen in the increased death rate and reduced birth rate.

*In 1949 China had the high birth and death rates characteristic of pre-industrial societies. Fifty years later both rates had fallen–the **demographic transition** from high b&d rates to low rates had taken place in a dramatically short time. For Demographic Transition Theory see P&B 56-9.

Measurement of Mortality

Death rates vary with age: they are high in the first year of life, fall dramatically, stay low and begin increasing again around age 40. (It is different in the AIDS affected populations of Africa.)

The age-specific death rate ${}_nM_x$ is the number of deaths to persons in a specific age group per 1000 persons in that age group (P&B 115)

$$ {}_nM_x = \frac{\text{deaths to persons aged } x \text{ to } x+n}{\text{midyear population aged } x \text{ to } x+n} \times 10($$

where n is the width of the age group and x is the initial year of the age group.

A related, but slightly different, concept is the probability of a person aged x dying before reaching age $x+n$. This is estimated by omitting the 1000 and taking the denominator as the population alive at the beginning of the age interval. It will be denoted by ${}_nq_x$.

Relation between age-specific & crude death rates

Because the total of deaths in the population is the sum of the deaths in each age group we have

$$CDR = \frac{\sum_n {}_nM_x \ {}_nP_x}{P} \times 1000$$

where $P =$ total population and ${}_nP_x$ is the population aged x to $x+n$.

The expression can be re-arranged

$$CDR = \sum_n \left(\frac{{}_nP_x}{P} \right) {}_nM_x$$

so that the CDR is a **weighted average**

of the age-specific DRs with weights equal to the share of each age group in the total population.

Life expectancy and the Life table (P&B 120)

Life expectancy at a particular time for a person at a particular age is the number of further years a person may be expected to live if she is subjected to the age-specific probabilities of dying ruling at that time. These probabilities have changed substantially in China over the past 60 years so that life expectancy has risen from around 40 to around 70 years of age.

The figure shows life expectancy at birth for a person born in China in the recent past and projected into the future.

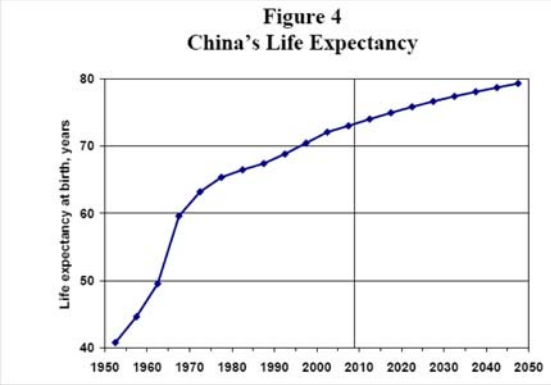

Figure 4 of Banister et al. (2010)

Figures for life expectancy at different ages are obtained from the **life table**, the basic technique for studying mortality. It is constructed from ${}_nM_x$ information.

The life table consists of the probability of dying between age x and $x+n$ (the ${}_nq_x$ defined above), the number of survivors at each age x (l_x), the number of deaths in each age interval (${}_nd_x$), the number of years lived in each age interval (${}_nL_x$) and life expectancy at each age (e_x).

The probability of dying in the interval can be calculated from the ${}_nM_x$.

Here is an extract from the UK life table

based on the years 1992-94 for males of selected ages.

x	m_x	q_x	l_x	d_x	e_x
0	0.007125	0.007099	100000.0	709.9	73.93
1	0.000545	0.000545	99290.1	54.1	73.46
2	0.000339	0.000339	99235.9	33.6	72.50
3	0.000242	0.000242	99202.3	24.0	71.52
22	0.000861	0.000861	98517.5	84.8	52.93
23	0.000813	0.000812	98432.7	80.0	51.97
24	0.000851	0.000850	98352.7	83.6	51.02
25	0.000813	0.000812	98269.1	79.8	50.06
26	0.000869	0.000869	98189.3	85.3	49.10
56	0.008217	0.008184	90923.7	744.1	21.38
57	0.009555	0.009509	90179.6	857.6	20.55
58	0.010433	0.010379	89322.0	927.1	19.74
59	0.011734	0.011665	88394.9	1031.2	18.94
60	0.013105	0.013020	87363.8	1137.5	18.16

Birth rates

We saw the crude birth rate above

$$CBR = \frac{\text{number of births}}{\text{midyear population}} \times 1000.$$

As with death rates there are other more refined concepts.

The **general fertility rate** takes into account the number of females of child bearing age (P&B 41)

$$GFR = \frac{\text{births}}{\text{midyear pop}_{f,15\text{–}49}} \times 1000$$

Age-specific fertility rates focus on births to women according to their age. In the case of women in age group x to $x + n$ it is (P&B 44)

$$ASFR_{x \text{ to } x+n} = \frac{\text{births}_{x \text{ to } x+n}}{\text{females}_{x \text{ to } x+n}} \times 1000$$

The **total fertility rate** is an estimate of the number of births that a hypothetical group of 1000 women would have during their reproductive lifetime.

Naughton (170) quotes an estimated TFR for Shanghai in 2000 of 0.68 births per woman.

The TFR is computed by summing the ASFRs after multiplying by the width of the age interval (P&B 46)

$$TFR = \sum ASFR_{x \text{ to } x+n} \times i$$

Age and sex structure: **Population pyramids** (P&B 240ff)

The age and sex structure of a population can be presented in the form of a ‘pyramid.’ This consists of two back to back histograms showing the proportions of each sex in each age group. In recent decades family planning campaigns and from 1980 the one child policy–see Naughton ()–have eaten away at the base of the Chinese pyramid.

Figure 6
China's Population by Age and Sex, 1964, 1982, and 2000

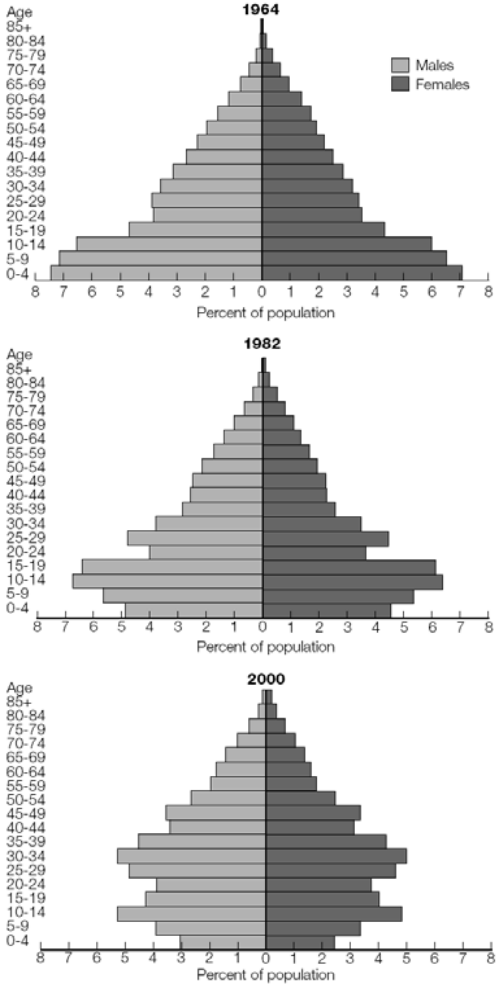

Figure 6 of Riley (2004)

Additional References

*Judith Banister, David E. Bloom,

and Larry Rosenberg (2010) Population Aging and Economic Growth in China, PGDA Working Paper No. 53 http://www.hsph.harvard.edu/pgda/working
*Nancy E. Riley (2004) China's Population: New Trends and Challenges, *Population Bulletin*, **59**, 1-40.
*Frank Dikötter (2010) *Mao's Great Famine : the History of China's Most Devastating Catastrophe, 1958-62*, Bloomsbury Press.