Mortality and its Measurement: Standardizing CDR

Demography Camp

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1 We would like to have a single index of mortality

Something that would respond to the question: What is the demographic significance of a given set of age-specific death rates? Can we summarize them in a compact way?

1.1 Returning to the Crude Death Rate

$$CDR = \frac{\text{Total Annual Deaths}}{\text{Mid-Year Population}}$$

$$CDR = \frac{D}{P}$$

$$CDR = \frac{\sum {}_nD_x}{P}$$

$$CDR = \frac{\sum {}_nM_x \cdot {}_nP_x}{P}$$

$$CDR = \sum {}_nM_x \cdot \left[\frac{{}_nP_x}{P}\right]$$

$$CDR = \sum {}_nM_x \cdot {}_nc_x, \; where \sum {}_nc_x = 1$$

Implications?

- The CDR is a **weighted average** of the prevailing age-specific death rates, where the weights are the proportions of the population at different ages.
- Comparisons among crude death rates can be misleading unless the population age distribution is the same in all cases.

- Sometimes age composition can reverse the appearance of relative mortality risks.

Examples:

- 1967: West Berlin and West Germany had the same mortality schedules (a new-born female had 90% chance of surviving to 55).
  - But, CDR = 18 in West Berlin and 11 in West Germany.
  - Why? In West Berlin, 21 percent of population 65+; 12 percent 65+ in West Germany.
- 1985: Mexicos CDR = 6 per 1,000; U.S. = 9 per 1,000
  - Yet female life expectancy at birth 11 years lower in Mexico than the US
  - Why? Mexicos very young age distribution produced a low CDR.

The dependence of the CDR on age structure is especially strong when mortality is low.

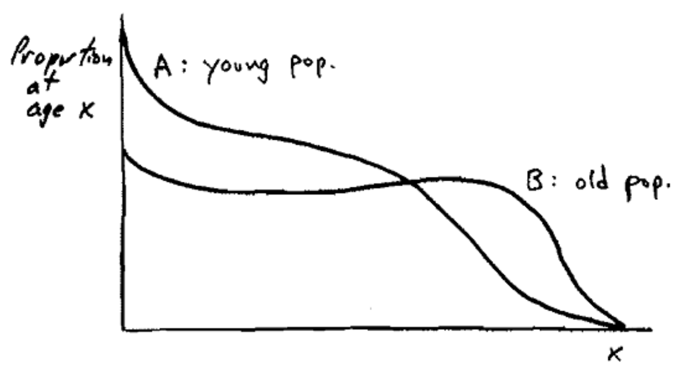

Figure 1: Two Age Structures

- If both A and B are subject to the same low mortality schedule, CDR higher in B.
- Not so great a difference if both subject to high mortality because population A gives large weight to high infant and childhood mortality.

1.2 Age-Standardized Crude Death Rates

To correct for the influence of age composition, one applies age-specific death rates to a constant **standard age distribution**.

$$CDR^s = \sum {}_nM_x \cdot {}_nc_x^s$$

Where ${}_nc_x^s$ is the proportion of the standard population in age interval x to x+n

Table 1: Example Standard Population: New Zealand 1966

	Crude Death Rate	Standardized Death Rate
Maori	6.37	13.88
No-Maori	9.07	8.68

Strengths of standardized rates:

- Holds age composition constant

Weaknesses of standardized rates;

- Selection of standard is arbitrary
- Results may depend on which standard is chosen
  - May not be so bad if time-trend comparisons are made within same country

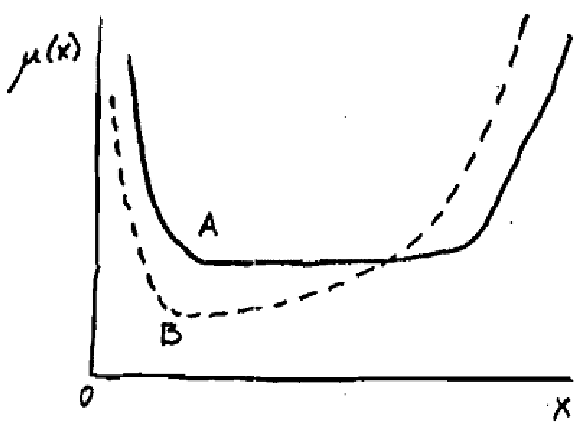

Figure 2: Extreme Example: Two mortality curves that cross

If a young standard population is used, $CDR_A^s > CDR_B^s$. Results reversed if old standard population is chosen.

Standardized rates still used for special purposes

- E.g., comparing death rates by cause of death in 2 countries (e.g. cardio-vascular)

2 Expectation of Life at Birth, $\mathring{e}_0$

- Preferred way of summarizing a set of age-specific death rates in a single index
- $\mathring{e}_0$ abstracts from the effects of age composition.

Definition $\mathring{e}_0$ = the average number of years that a cohort of individuals, all born at the same time, could expect to live if at each age, they were exposed to the death rates actually observed in a population in a given year.

Table 2: 10 Countries Ranked by CDR and $\mathring{e}_0$

2005	Ranking by CDR	Ranking by $\mathring{e}_0$
Sweden	9.5	2
Austria	8	4
Poland	9.5	7.5
Japan	6.5	1
El Salvador	4	10
Panama	3	7.5
Kuwait	2	5
U.A. Emirates	1	6
Thailand	5	9
Switzerland	6.5	3

Table 3: US $\mathring{e}_0$

	Males	Females
1985	71.2	78.2
1980	70	77.4
1970	67.1	74.7
2002	74.5	79.9

Need to consider **life tables** to understand $\mathring{e}_0$.