Constructing life tables

The experience of the CONCORD programme

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Constructing life tables: CONCORD-3 study

322 population-based cancer registries

Three categories of data obtained for life tables:

1. **Death and population counts**
   - ❑ Multivariable Poisson model with restricted cubic splines
2. **Mortality rates from National Statistics**
   - ❑ Ewbank method for smoothing mortality rates
3. **Abridged life tables from the UN Population Division**
   - ❑ Elandt-Johnson method

Multivariable Poisson model with restricted cubic splines

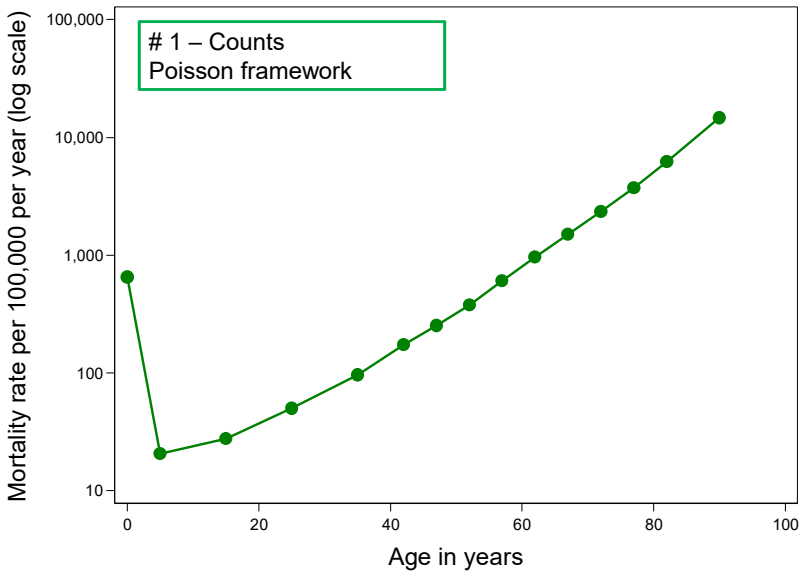
$$log(d_x) = \beta_0 + f(x) + log(pyrs_x)$$

- $log(d_x)$: Death counts by age
- $f(x)$: Spline function on age
- $log(pyrs_x)$: Age-specific person-year at risk

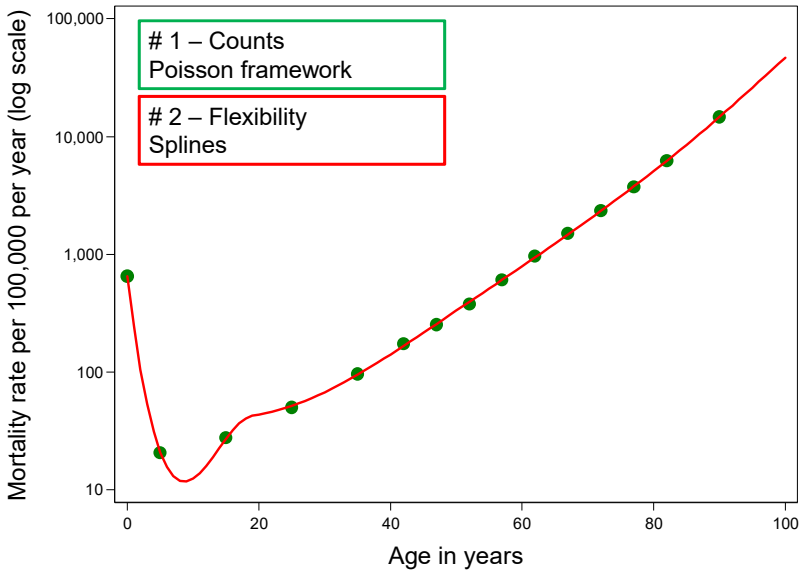
$$log(m_x) = \beta_0 + f(x)$$

Rachet et al, *2015*

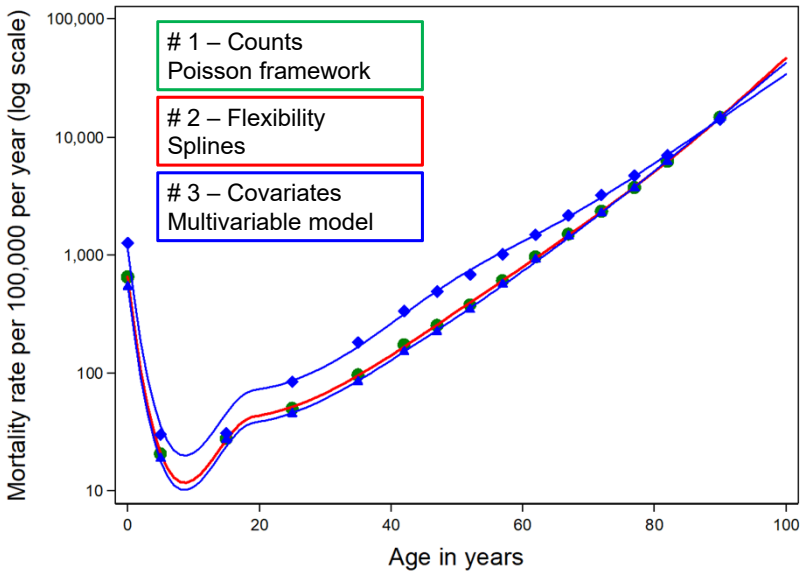
Poisson model



Poisson model with restricted cubic splines



Multivariable Poisson model with restricted cubic splines



Multivariable Poisson model with restricted cubic splines

- Mortality rates for men and women modelled separately
- Number of knots and knots location
- Life tables by race/ethnicity or for different geographical areas

$$log(d_{x,i}) = \beta_0 + f(x) + \sum_{i=2}^{3} \beta_i ethnicity_i + g(ageethnicity) + log(pyrs_x)$$

Main effect of ethnicity

Interaction between age and ethnicity

Smoothing raw mortality rates

Ewbank model – extension of Brass 2- parameter model

- ✓ Standard life table
- ✓ Model the logit(l_x)=Y_x=$0.5 \ln \frac{1-l_x}{l_x}$
- ✓ Linear relationship between the two survivorship functions
- ✓ Introduce 2 parameters:

Increase/decrease mortality compared to the standard

✓ logit(l_x)= α + β (logit(l_{xs}))

Younger/older mortality

Applies after the median age at death

✓ logit(l_x)= α + βT (l_{xs}; κ; λ))

Applies before the median age at death

Ewbank et al, *1983*

Elandt-Johnson method

Death and population counts

Mortality rates from National Statistics

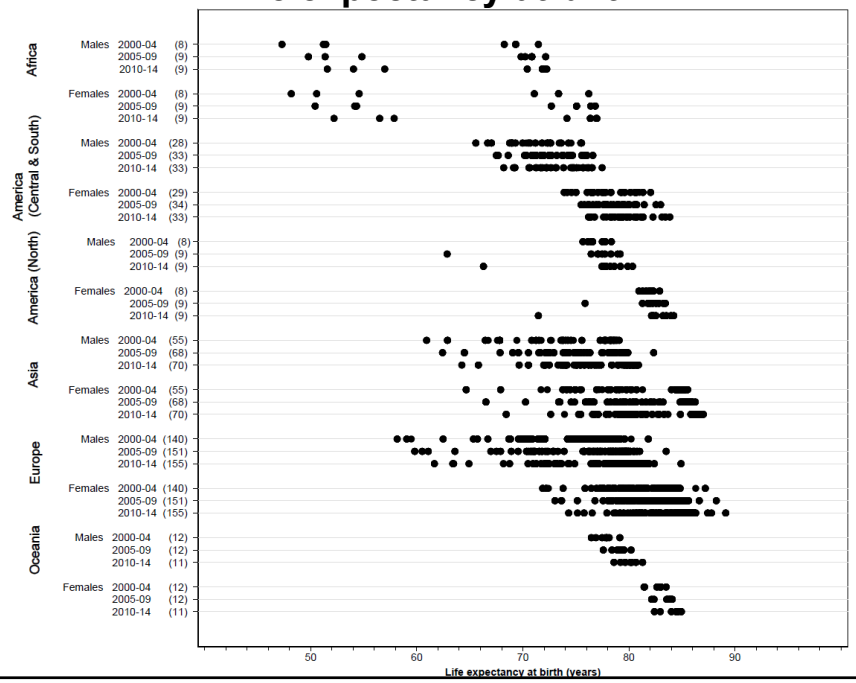
Not available or not reliable

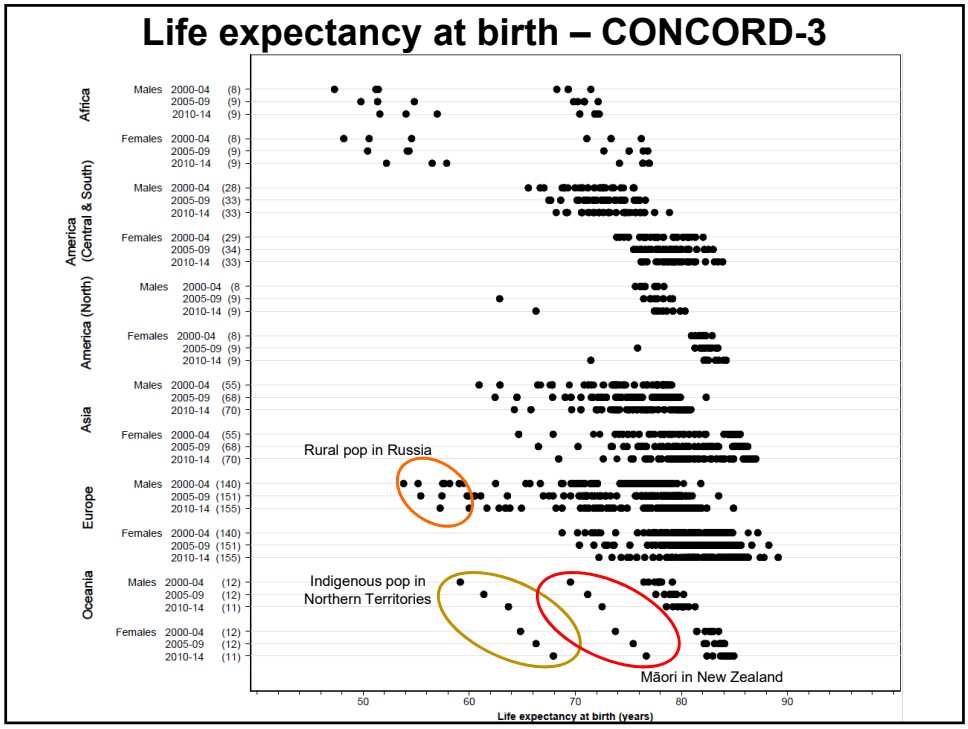
United Nation Population Division Life tables

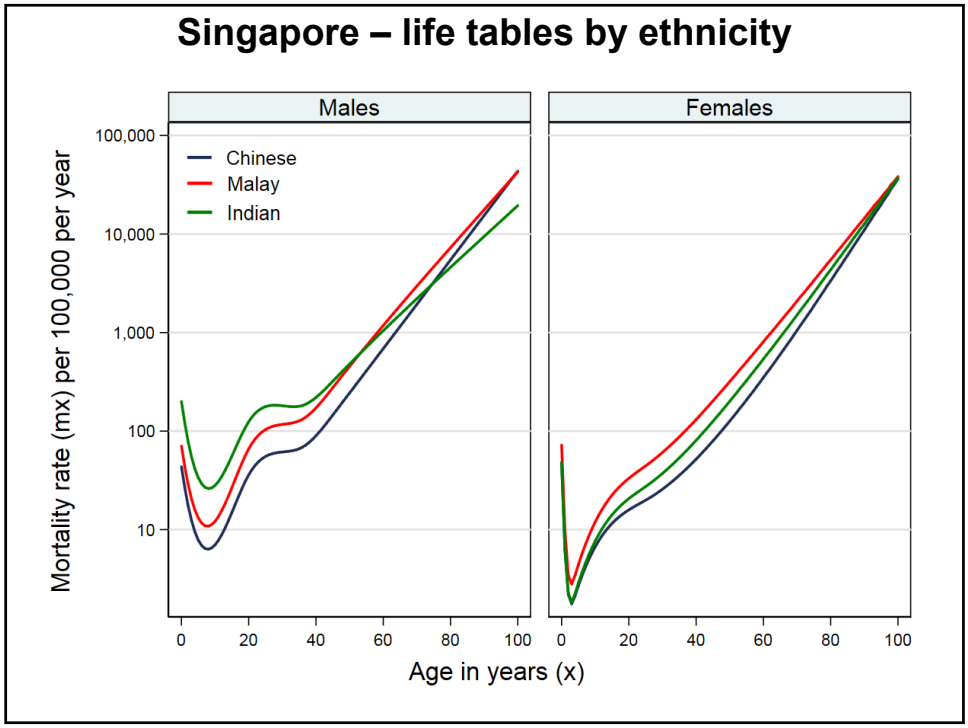
Region, subregion, country or area *	Period	Abridged life table, for females, by region, subregion and country										
		Age (x)	Central death rate m(x,n)	Probability of dying q(x,n)	Probability of surviving p(x,n)	Number of survivors l(x)	Number of deaths d(x,n)	Number of person-years lived L(x,n)	Survival ratio S(x,n)	Person-years lived T(x)	Expectation of life e(x)	Average number of years lived a(x,n)
Afghanistan	1950-1955	0	0.32005	0.26494	0.73506	100 000	26 494	82 779	0.68486	2 942 591	29.43	0.35
Afghanistan	1950-1955	1	0.05017	0.17721	0.82279	73 506	13 026	259 649	0.85692	2 859 812	38.91	1.36
Afghanistan	1950-1955	5	0.01051	0.05101	0.94899	60 480	3 085	293 435	0.95833	2 600 163	42.99	2.09
Afghanistan	1950-1955	10	0.00816	0.04000	0.96000	57 395	2 296	281 207	0.95492	2 306 729	40.19	2.49
Afghanistan	1950-1955	15	0.01073	0.05230	0.94770	55 099	2 882	268 531	0.94113	2 025 521	36.76	2.58
Afghanistan	1950-1955	20	0.01348	0.06523	0.93477	52 218	3 406	252 722	0.93081	1 756 990	33.65	2.54
Afghanistan	1950-1955	25	0.01512	0.07285	0.92715	48 812	3 556	235 236	0.92256	1 504 268	30.82	2.52
Afghanistan	1950-1955	30	0.01714	0.08219	0.91781	45 256	3 719	217 020	0.91386	1 269 032	28.04	2.51
Afghanistan	1950-1955	35	0.01884	0.08997	0.91003	41 537	3 737	198 325	0.90681	1 052 013	25.33	2.50
Afghanistan	1950-1955	40	0.02028	0.09648	0.90352	37 800	3 647	179 844	0.90067	853 687	22.58	2.49
Afghanistan	1950-1955	45	0.02192	0.10396	0.89604	34 153	3 551	161 979	0.88285	673 844	19.73	2.53
Afghanistan	1950-1955	50	0.02854	0.13337	0.86663	30 602	4 081	143 003	0.85112	511 864	16.73	2.55
Afghanistan	1950-1955	55	0.03665	0.16821	0.83179	26 521	4 461	121 713	0.79892	368 862	13.91	2.56
Afghanistan	1950-1955	60	0.05444	0.23997	0.76003	22 060	5 294	97 239	0.72699	247 149	11.20	2.53
Afghanistan	1950-1955	65	0.07411	0.31248	0.68752	16 766	5 239	70 691	0.63584	149 910	8.94	2.49
Afghanistan	1950-1955	70	0.10992	0.42861	0.57139	11 527	4 941	44 948	0.51201	79 219	6.87	2.43
Afghanistan	1950-1955	75	0.16084	0.56201	0.43799	6 586	3 702	23 014	0.37755	34 270	5.20	2.32
Afghanistan	1950-1955	80	0.23240	0.69996	0.30004	2 885	2 019	8 689	0.22809	11 256	3.90	2.16
Afghanistan	1950-1955	85	0.33713	...	...	866	866	2 567	...	2 567	2.97	2.97

Elandt-Johnson, *1980*

Life expectancy at birth




Life expectancy at birth – CONCORD-3
Africa
America (Central & South)
America (North)
Asia
Europe
Oceania
Males 2000-04 (8)
2005-09 (9)
2010-14 (9)
Females 2000-04 (8)
2005-09 (9)
2010-14 (9)
Males 2000-04 (28)
2005-09 (33)
2010-14 (33)
Females 2000-04 (29)
2005-09 (34)
2010-14 (33)
Males 2000-04 (8
2005-09 (9)
2010-14 (9)
Females 2000-04 (8)
2005-09 (9)
2010-14 (9)
Males 2000-04 (55)
2005-09 (68)
2010-14 (70)
Females 2000-04 (55)
2005-09 (68)
2010-14 (70)
Males 2000-04 (140)
2005-09 (151)
2010-14 (155)
Females 2000-04 (140)
2005-09 (151)
2010-14 (155)
Males 2000-04 (12)
2005-09 (12)
2010-14 (11)
Females 2000-04 (12)
2005-09 (12)
2010-14 (11)
Rural pop in Russia
Indigenous pop in Northern Territories
Māori in New Zealand
50
60
70
80
90
Life expectancy at birth (years)


Singapore – life tables by ethnicity
Males
Females
Chinese
Malay
Indian
Mortality rate (mx) per 100,000 per year
100,000
10,000
1,000
100
10
0
20
40
60
80
100
Age in years (x)