PROJECTED NZ LIFE TABLES

Burden of Disease Epidemiology, Equity and Cost-Effectiveness Programme (BODE³)

Technical Report: Number 4

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Goal: Obtain New Zealand life tables by ethnicity by sex by deprivation (approximate tertiles) for the time period 2006-2026.

Tertiles are approximate, and we use actual deciles 1-3 (30%), deciles 4-7 (40%) and deciles 8-10 (30%), hereafter just called tertiles.

The approach we used here is consistent with the methodology developed in Carter et al [1]. Namely, we use death rates from "official" 2006 New Zealand life tables, the proportions of the New Zealand population in deprivation groups and corresponding rate ratios to obtain death rates for deprivation groups of interest.

Input Data:

1. New Zealand 2006 "official" life tables (from ages 0 to 100 years) by ethnicity by sex. "nz-complete-tables-2006.xls"[1]. Source - http://www.stats.govt.nz/browse_for_stats/population/births/new-zealand-life-tables-2005-07.aspx [2].
2. New Zealand 2006 life tables (0-85) by ethnicity by sex by 5 deprivation groups, deciles 1-2,deciles 3-4, deciles 5-6, deciles 7-8, deciles 9-10. Hereafter just called quintiles. "Deprivation quintiles.xls". Source – Ministry of Health
3. New Zealand population 2006 proportions (0-95+) for quintiles by ethnicity by sex. "Deprivation proportions.xls". Source - University of Otago.

Output Data: New Zealand life tables 2006-2026 (0-110) by ethnicity by sex by deprivation tertiles.

Methodology[*]:

1. Using Gompertz-Makeham parametric model for old age mortality, $m_x = c + be^{ax}$, we extrapolated death rates from 100 to 110. ("Gompertz.xls" spreadsheet.)

2. Aggregate quintile counts, N_{1-2}, N_{3-4}, N_{5-6}, N_{7-8}, N_{9-10} into tertiles N_{1-3}, N_{4-7}, N_{8-10}.

$$N_{1-3} = N_{1-2} + \frac{N_{3-4}}{2}$$

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[1] Excel and other files used in the calculation of the full lifetables are referenced throughout this Technical Report. They are archived on the BODE[3] directory – see page 5. Interested parties external to the University of Otago, Wellington, should contact the authors of this Report if they would like copies of these files.

$$N_{4-7} = \frac{N_{3-4}}{2} + N_{5-6} + \frac{N_{7-8}}{2}$$
$$N_{8-10} = \frac{N_{7-8}}{2} + N_{9-10}.$$

Obtain proportions:

$$p_{1-3} = \frac{N_{1-3}}{N}, p_{4-7} = \frac{N_{4-7}}{N}, p_{8-10} = \frac{N_{8-10}}{N}$$

Where $N = N_{1-3} + N_{4-7} + N_{8-10}$.

Done in "Proportion dep distribution" sheet of "Maori Male by Dep.xls" spreadsheet.

3. Using linear regression for death rates across quintiles of deprivation (by ethnicity), estimate mortality rate ratios by tertiles of deprivation.
$$m = aDep + b$$
$$m = (m_{1-2}, m_{3-4}, m_{5-6}, m_{7-8}, m_{9-10})$$

$$Dep = (0.1, 0.3, 0.5, 0.7, 0.9)$$

a and b is derived for each age group.

Using corresponding regression equation, RRs are derived for each age group:

$$RR_{4-7} = \frac{m_{4-7}}{m_{1-3}} = \frac{a * 0.5 + b}{a * 0.15 + b}$$
$$RR_{8-10} = \frac{m_{8-10}}{m_{1-3}} = \frac{a * 0.85 + b}{a * 0.15 + b}$$

(The proportion multiplied by a in each instance corresponds to the mid-point of the relevant deprivation tertile on a cumulative proportion scale.)
We used adjacent period weighting to smooth RRs,

$$\ln(SmRR(k)) = 0.25 * \ln(RR(k-1) + 0.5 * \ln(RR(k)) + 0.25 * \ln(RR(k+1)$$
$$\ln(SmRR(1)) = 0.67 * \ln(RR(1) + 0.33 * \ln(RR(2))$$
$$\ln(SmRR(20)) = 0.33 * \ln(RR(19) + 0.67 * \ln(RR(20))$$

Where $k = 2,..,19$ and $SmRR(k)$ is smoothed rate ratio for k–th age group.

Then we obtain RRs by single age using linear splines on logarithmic scale.

These rate ratios are presented in the "RR by age" sheet of the "Maori Male by Dep.xls" spreadsheet.

4. Using RRs by tertiles (RR_{4-7}, RR_{8-10}), proportion distribution of population by tertiles $(p_{1-3}, p_{4-7}, p_{8-10})$ and "official" New Zealand death rates (m), extrapolated up to 110, we can obtain 2006 death rates by deprivation tertiles.

$$m = m_{1-3} * p_{1-3} + m_{4-7} * p_{4-7} + m_{8-10} * p_{8-10} =$$
$$m_{1-3} * p_{1-3} + m_{1-3} * RR_{4-7} * p_{4-7} + m_{1-3} * RR_{8-10} * p_{8-10}$$

$$m_{1-3} = \frac{m}{p_{1-3} + RR_{4-7} * p_{4-7} + RR_{8-10} * p_{8-10}}$$

$$m_{4-7} = m_{1-3} * RR_{4-7}$$

$$m_{8-10} = m_{1-3} * RR_{8-10}$$

These are presented in the "Mx by dep by age" sheet of the "Maori Male by Dep.xls" spreadsheet.

5. Project 2006 death rates by deprivation tertiles from 2006 to 2026 time period, assuming 2.25% and 1.75% yearly reduction for Maori and Non Maori respectively. (These 2.25% and 1.75% estimate are the average annual percentage declines in mortality rates from two sources: those reported by Statistics New Zealand [3] and derived and used by Carter et al [1]) These death rates are presented in the "MaoriMale2026.xls" spreadsheet.

Comment

The lifetables will be used to estimate background mortality rates in disease models within BODE[3]. By allowing for variation by sex, age, ethnicity and deprivation (consistent with the ethos of BODE[3] to examine population heterogeneity and equity), these lifetables will allow more accurate estimates of (say) years of life lost across sub-populations. We make assumptions about the future annual percentage reduction in

mortality rates by ethnicity (but not allowing for variation by sex, age and deprivation). These assumptions are reasonable, but unlikely to be exactly correct – for example, we have not allowed for cohort effects. Nevertheless, given other uncertainties in future BODE[3] modeling, the uncertainty in predicted future background mortality rates (from these lifetables) will not be a major driver of total model uncertainty. We predict out to 2026, but then assume mortality rates beyond 2026 remain constant. Given that all health gains/losses in modeling will be discounted back to 2006 present values, this conservative assumption of fixed mortality rates beyond 2006 will not have a major impact on BODE[3] model outputs.

Spreadsheets

These excel spreadsheets can be found within three subfolders : Input Data, Derivation-Methodology and Output Data within the BODE³ shared drive, internal to the University of Otago, Wellington.

Subfolder **Input Data** contains 3 spreadsheets:
1. "nz-complete-tables-2006.xls"
2. "Deprivation quintiles.xls"
3. "Deprivation proportions.xls"

Subfolder **Derivation-Methodology** contains 9 spreadsheets:
1. "Gompertz.xls"
2. "Maori Male by Dep.xls"
3. "Maori Female by Dep.xls"
4. "Non_maori Male by Dep.xls"
5. "Non_maori Female by Dep.xls"
6. "MaoriMale2026.xls"
7. "MaoriFemale2026.xls"
8. "NonMaoriMale2026.xls"
9. "NonMaoriFemale2026.xls"

Subfolder **Output Data** contains 4 spreadsheets:
1. "MaoriMale-static.xls"
2. "MaoriFemale-static.xls"
3. "NonMaoriMale-static.xls"
4. "NonMaoriFemale-static.xls"

Spreadsheets "MaoriFemale2026.xls", "NonMaoriMale2026.xls" and NonMaoriFemale2026.xls" are derived with analogous method.

References

1. Carter, K., T. Blakely, and M. Soeberg, *Trends in survival and life expectancy by ethnicity, income and smoking in New Zealand: 1980s to 2000s.* NZ Med J, 2010. **123**: p. 1-13.

2. Statistics New Zealand, *New Zealand Life Tables: 2005-07.* 2009, Statistics New Zealand: Wellington.

3. Statistics New Zealand, *SNZ Summary Profile for Information about the Demographic Projections*, 2006, Statistics New Zealand: Wellington.