Life-course predictors of mortality inequalities

COMPASS Colloquium
Statistics New Zealand
Wellington, July 29 2015

Barry Milne

COMPASS Research Centre
University of Auckland
www.compass.auckland.ac.nz

DISCLAIMER: Access to the data used in this study was provided by Statistics New Zealand under conditions designed to give effect to the security and confidentiality provisions of the Statistics Act 1975. The results presented in this study are the work of the author, not Statistics New Zealand.
Outline

- Background & Aims

- Methods
  - New Zealand Longitudinal Census (NZLC)
  - New Zealand Census Mortality Study (NZCMS)

- Some early results
  - Siblings discordant for income
  - Unemployment

- Conclusions and Next Steps
Background

- Mortality rates in New Zealand (and worldwide) continue to decline
  - Number of deaths per year standardised by age, sex
- But socio-economic inequalities have increased (or, at least, not decreased)
  - Large variation in mortality rates by socio-economic conditions (and ethnicity)
- What can be done about this?
  - Need to understand nature of socio-economic influences in mortality in New Zealand, and the factors that ameliorate the effects of socio-economic risk.
Background

New Zealand Census Mortality Study (NZCMS)
- Linked Mortality Data to each Census from 1981–2006
- Number of proximal factors important
  - Socio-economic status (SES), ethnicity, smoking, air pollution
- Determine time trends and cause of death trends

New Zealand Longitudinal Census (NZLC)

Linking the two gives up to 25 years of socio-economic & other data linked to mortality
- Understand life-course factors important for mortality
Aims

Four research aims:

1. To test which ‘life-course hypotheses’ best explain associations between socio-economic status and mortality
2. To test whether social and cultural factors protect against socio-economic risk
3. To assess whether ethnic disparities in mortality are explained by the greater experiences of long-term socio-economic disadvantage
4. To assess mortality among siblings discordant for (i) socio-economic risk, or (ii) social and cultural factors
Life course Hypotheses
1. Accumulation

- Socio-economic influence on mortality accumulates across the life-course
  - Mortality risk increases with increasing time in poverty

Evidence?
- Number of life stages spent in low occupational SES linearly associated with cardiovascular and all-cause mortality (Sweden: Rosvall et al., 2006)
Life course Hypotheses
2. Critical/sensitive period

**Critical period**
- Socio-economic circumstances affect mortality *only* when experienced at certain periods of life

**Sensitive period**
- Effect of socio-economic experiences on mortality are *stronger* at some ages than others.

**Evidence?**
- Socio-economic deprivation experienced age 50-65 had stronger effects on mortality than that experienced earlier (Sweden: Mishra et al., 2013)
Life course Hypotheses
3. Social Mobility

- Directional change in socio-economic circumstances impact mortality
  - Mortality risk increases with deteriorating socio-economic conditions; and decreases with improving socio-economic conditions

- Evidence?
  - Mortality risk doubled among those whose socio-economic circumstances deteriorated from childhood to adulthood (Finland: Lynch et al., 1994)
Life course Hypotheses
4. Instability

- Unstable socio-economic conditions over the life-course will be associated with mortality
  - Mortality risk increases with increasing socio-economic instability

Evidence?
- Unpredictable incomes associated with mortality (USA: McDonough et al., 1987)
- Unpredictable environments have independent (and possibly stronger) effects than harsh environments on health
Life course Hypotheses

Intervention Implications

- **Accumulation hypothesis** suggests an intervention targeting all age groups.

- **Critical/Sensitive period hypothesis** suggests intervention at certain life-stages only.

- **Mobility hypothesis** suggests lifting people out of poverty (or preventing slides into poverty) should be an intervention target.

- **Instability hypothesis** suggests buffering against unpredictability.
Social and Cultural Factors

What ameliorates effects of socio-economic conditions?

- Important from intervention point of view

- Social factors? Social support has been shown to lower mortality risk
  - Other factors: volunteering

- Cultural factors? Ethnic density (neighbourhood concentration of one’s own ethnic group) has been associated with better health among Māori, and with mortality in other jurisdictions
  - Other factors: language, religion, time in New Zealand
Life-course explanations for ethnic disparities

- Ethnic disparities in mortality in NZ are large
  - Māori have mortality rates that are 2.5 times, and Pacific 1.6 times, that of non-Maori, non-Pacific.

- 30-40% of inequalities between Māori and non-Māori explained by socio-economic factors in the years immediately preceding death.
  - How much could be explained if socio-economic factors were assessed over a greater portion of the life course?
  - And do social and cultural factors play a role
Discordant Sibling Analyses

- Use of a Census cohort containing data within family units allows us to compare mortality rates for siblings differently exposed to socio-economic risk

  - ‘Discordant sibling design’ eliminates confounding associated with shared family background, and partly controls for genetic confounding

- RQ: Is life course SES associated with mortality once family background effects have been controlled using a discordant sibling design
Questions?
Methods
- Overview

- **Link**
  Longitudinal census records (NZLC)

- **To**
  Mortality records (NZCMS)
    - 3 years following 1986, 1991 and 1996 censuses
    - 5 years following 2001 and 2006 censuses

- **Using**
  Census IDs
Privacy and Ethics

- Individuals not identifiable, and not monitored. Group comparisons only

- Two privacy impact assessments undertaken for NZLC
  - “risk to an individual of a privacy breach is extremely low”
  - Risk of breach no greater than for individual census data use

- NZCMS undergone privacy assessment and has ethical approval from the Central Regional Ethics Committee

- University of Auckland Human Ethics Committee granted approval for proposed research (ref 012400)
NZLC
- What is it?

  - ‘Backwards’: t,t-1 (e.g., 2006->2001)

- Theoretical population: those >=5yo who have lived in the country for at least 5 years (82-88% of total popn)

- Largely deterministic, based on sex, dob, area of residence 5y ago, (country of birth, Māori descent)
  - Approx 3% probabilistic

- 15 cohorts altogether
  - Joining links of adjacent Censuses
## NZLC - 15 Cohorts

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>06-01-96-91</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01-96-91-86</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>96-91-86-81</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Linkage Bias
- Why an issue with NZLC?

- Linkage bias is a specific type of ‘selection bias’
  - Those linked (selected) differ from those not linked
  - X-Y associations in the selected sample differ from X-Y associations in the full sample

- Bias likely because
  - Incomplete linkage (31%-75% of population)
  - Linkage varies as a function of various factors
    • Age, Sex, Residential mobility, Deprivation, Relationship Status, Housing Tenure, Ethnicity

- Are associations biased?
Linkage Bias
- Why an issue with NZLC?

- CAN’T assess full extent of bias
  - Don’t know associations among the unlinked

- BUT each linked cohort is nested within another (or within a single Census)

- So, CAN assess bias of nested cohort against cohort (or Census) one level up. E.g.,
  - Among those linked back from 2006 to 2001, are 2006 associations biased?
  - Among those linked back from 2006 to 1996, are 2006-2001 associations biased?
Linkage Bias - Can we adjust for it?

- Compare two-way correlations
  - Full census vs sample linked back to previous census
  - Consider <.01 magnitude differences as unbiased...
  - Modest improvement across all cohorts; more for adults
  - Similar results for ‘longer’ cohorts (3+ censuses)

**Children, 5-14**

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Unweighted</th>
<th>Weighted</th>
</tr>
</thead>
<tbody>
<tr>
<td>86-81</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>91-86</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>96-91</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>01-96</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>06-01</td>
<td>0.8</td>
<td>0.8</td>
</tr>
</tbody>
</table>

**Adult, 15+**

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Unweighted</th>
<th>Weighted</th>
</tr>
</thead>
<tbody>
<tr>
<td>86-81</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>91-86</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>96-91</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>01-96</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>06-01</td>
<td>0.8</td>
<td>0.8</td>
</tr>
</tbody>
</table>
However, few associations with mortality biased (except 1986-81)
NZCMS - What is it?

- Probabilistic linkage of each Census (1981-2006) to subsequent (3 or 5 year) mortality records
  - Proportion of mortality records linked ranges from 71% (1981) to 81% (2001)
  - Accuracy of linkage estimated at 97-98%.
  - We don’t use 1981 mortality records (no longitudinal link back)

- Bias weights (similarly) estimated based on the characteristics predicting linkage
Preliminary Analyses

- A first peek (preliminary)
- Adjusted for bias (NZLC bias weight x NZCMS bias weight)
- Logistic regression only (dead vs not)
- All cause mortality only
- Analyses among those surviving 1981-2006, who then died (or not) in the subsequent 5 years
- Rudimentary longitudinal variables
1. Sibling comparisons
- Income and mortality

- Is the effect of income on mortality due to familial confounding?

- Test by comparing mortality risk (2006-2010) among siblings discordant for income:
  - Number of times in lowest income quintile 1981-2006
  - Controls: birth order (age), sex, socio-economic factors (education, unemployment, motor vehicle access), family factors (household size and structure, residential moves), disability

- First task is to identify sibling pairs
1. Sibling comparisons
- Identifying sibling pairs

From 1981 census
All individuals
2.88 million

Family code ‘00’
1st family in the dwelling
Sibling pairs in 1981
Linked from 1981-2006

Family code ‘01’
Son/daughter to occupier

Family code ‘02’
Son/daughter to occupier
(n~517,000 pairs)

Family code ‘03’...

Family code ‘05’
(n~32,000 pairs)

Family code ‘06’...
1. Sibling comparisons - Income and mortality

- Increased odds of death among ‘poorer’ sibling
1. Sibling comparisons
- Income and mortality

Increased odds of death among ‘poorer’ sibling

- Age & Gender
- Socioeconomic factors
1. Sibling comparisons - Income and mortality

**Increased odds of death among ‘poorer’ sibling**

- Age & Gender
- Socioeconomic factors
- Family factors
1. Sibling comparisons - Income and mortality

Increased odds of death among ‘poorer’ sibling

- Age & Gender
- Socioeconomic factors
- Family factors
- Disability
1. Sibling comparisons
- Income and mortality

Increased % mortality, poorer sibling

<table>
<thead>
<tr>
<th>Number of additional times in poverty</th>
<th>Excess deaths compared to richer sibling (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.55%</td>
</tr>
<tr>
<td>2</td>
<td>1.25%</td>
</tr>
<tr>
<td>3+</td>
<td>2.10%</td>
</tr>
</tbody>
</table>
2. Unemployment and mortality

- Evidence that periods of unemployment and mortality
  - Mostly short term
  - Often comparing country/state unemployment rates and their effect on mortality rates (as opposed to associations at the individual level)

- Assess impact of number of times unemployed 1981-2006 on subsequent mortality 2006-2010
  - Control factors: Age and gender, education, socio-economic factors (education, deprivation, crowding, tenure), smoking, family structure, disability)
2. Unemployment and mortality

Unemployment and Mortality

- Odds Ratio (95% CI)

Age & Gender

- Once
- Two or more
2. Unemployment and mortality

Unemployment and Mortality

<table>
<thead>
<tr>
<th>Odds Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>1.5</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>2.5</td>
</tr>
</tbody>
</table>

- **Once**
- **Two or more**

Age & Gender

Ethnicity
2. Unemployment and mortality

Unemployment and Mortality

![Graph showing odds ratio (95% CI) for unemployment and mortality across different factors like Age & Gender, Ethnicity, and Socio-economic factors. The graph compares the odds ratio for unemployment once and two or more times.](image-url)

- **Odds Ratio (95% CI)**
- **Age & Gender**
- **Ethnicity**
- **Socio-economic factors**

- **Once**
- **Two or more**
2. Unemployment and mortality

Unemployment and Mortality

Odds Ratio (95% CI)

- Once
- Two or more

Factors:
- Age & Gender
- Ethnicity
- Socio-economic factors
- Smoking

The graph shows the odds ratio of mortality associated with unemployment, differentiated by the number of times unemployed (once vs. two or more) across various factors. The data suggests a higher mortality risk with increased unemployment frequency.
2. Unemployment and mortality

Unemployment and Mortality

Odds Ratio (95% CI)

- Once
- Two or more

Factors:
- Age & Gender
- Ethnicity
- Socio-economic factors
- Smoking
- Family structure
2. Unemployment and mortality

Unemployment and Mortality

![Graph showing the relationship between unemployment and mortality with 95% confidence intervals for different factors such as age, gender, ethnicity, socio-economic factors, smoking, family structure, and disability.](image)

- Red dots represent unemployment once.
- Blue dots represent unemployment two or more times.

Factors:
- Age & Gender
- Ethnicity
- Socio-economic factors
- Smoking
- Family structure
- Disability
Conclusions

- LOTS of possibilities with these data
  - More nuanced analyses, with more sensitive variables, will help elucidate association between life-course SES and mortality, and mediating factors

- Early analyses are revealing
  - Association between life-course poverty and mortality robust to family confounding
  - Periods of unemployment increase risk of mortality (mediated by other socio-economic factors, family turmoil and disability)
Next Steps

- Test the life-course hypotheses
- Investigate how much of ethnic differences in mortality risk is explained life-course socio-economic experiences
- Further test of sibling analyses
- Explore the role of social and cultural factors
  - Ethnic density appears to have some effects (need to disaggregate by ethnicity)
  - Living alone (lack of social support) also appeared to be important
Acknowledgments

- Stats NZ: Robert Didham, Kirsten Nissen, Wendy Dobson, Microdata Access team
- COMPASS team: Peter Davis, Roy Lay-Yee, Jessica McLay, Vera Puti Puti Clarkson, Rahul Singhal, Liza Bolton, Fui Swen Kuh, Justin Gunter
- Others: Tony Blakely, June Atkinson, Andrew Sporle, Alan Lee
References

Accumulation hypothesis

Critical period

Mobility hypothesis

Instability hypothesis

Social and cultural factors

Ethnic associations
Blakely T, et al. (2006). What is the contribution of smoking and socioeconomic status to ethnic inequalities in mortality in New Zealand? Lancet, 368, 44-52

Sibling Analyses