Socioeconomic status and all-cause mortality: Testing life course hypotheses in New Zealand

COMPASS Autumn Seminar Series
March 11th, 2016

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Abstract

Socioeconomic status (SES) has been shown to be related to mortality in a range of contexts. Low SES tends to increase mortality risk, but how exposure patterns across the life-course are related to mortality is not well understood, and have not been explored in the New Zealand context. This research uses New Zealand longitudinal census data to explore whether there is evidence of associations between mortality and cumulative exposure to low SES (accumulation hypothesis), changes in SES between life stages (social mobility hypothesis) and exposure to low SES during specific life stages (sensitive period hypothesis). Understanding these hypotheses in the New Zealand context may allow for better-targetted interventions to address mortality inequalities, for example, disparities between ethnic groups.

Keywords: accumulation, social mobility, sensitive period, mortality, New Zealand, socioeconomic status
Outline

1. Introduction
2. Longitudinal Census and NZCMS
3. Life-Course Hypotheses
4. Example Results
5. Model Fits
6. Conclusions

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.

University of Auckland Human Participants Ethics Committee (UAHPEC) approval number 012400
Introduction
Project Context

This research is part of the first year of my PhD project, examining life-course predictors of mortality inequalities across ethnic groups in Aotearoa New Zealand.

Wish to acknowledge the support of:

• Health Research Council Grant [14/167]
• University of Auckland Doctoral Health Research Scholarship
Social and Life-Course Epidemiology

Social Epidemiology

Year

Life-Course Epidemiology

Socioeconomic Status (SES)
Aims

• Model life-course SES association with mortality

• Test fit of hypotheses against saturated models
Longitudinal Census and NZCMS

The Data
Longitudinal Census and NZCMS

• The New Zealand Census-Mortality Study probabilistically links mortality records to census records.
• Both have linkage bias, weights have been created to help address this.
## Census Linkage Summary

<table>
<thead>
<tr>
<th></th>
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<td>1,581,000</td>
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<td>647,000</td>
<td>31.5</td>
</tr>
</tbody>
</table>

Source: Statistics New Zealand
Life-Course Models

The Method
Socioeconomic Trajectories

Time 1
High SES ————> Low SES ————> Low SES

Time 2
High SES ————> High SES ————> High SES

Time 3
High SES ————> High SES ————> High SES

Death?
8 Possible Trajectories

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## Life-Course Hypotheses

<table>
<thead>
<tr>
<th>Accumulation</th>
<th>Sensitive Period</th>
<th>Social Mobility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumulative exposure to low SES</td>
<td>Exposure to low SES at specific time</td>
<td>Movement out of or into low SES</td>
</tr>
</tbody>
</table>

- **Sensitive!**
- **Not Sensitive**

1. Up
2. Down
## Accumulation

<table>
<thead>
<tr>
<th>Number of census times at risk</th>
<th>Trajectories</th>
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<td>H</td>
</tr>
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<tr>
<td>3</td>
<td>H</td>
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<tr>
<td></td>
<td>L</td>
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</table>

The table shows the accumulation of census times at risk, with each row representing a different number of census times and the corresponding trajectory patterns.
# Sensitive Period Trajectories

<table>
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<th>Sensitive Period</th>
<th>Trajectories</th>
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<tr>
<td><strong>Time 1</strong></td>
<td><img src="image" alt="Trajectory Diagram" /></td>
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<td><img src="image" alt="Trajectory Diagram" /></td>
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<tr>
<td></td>
<td><img src="image" alt="Trajectory Diagram" /></td>
</tr>
<tr>
<td><strong>Time 2</strong></td>
<td><img src="image" alt="Trajectory Diagram" /></td>
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<tr>
<td></td>
<td><img src="image" alt="Trajectory Diagram" /></td>
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<tr>
<td></td>
<td><img src="image" alt="Trajectory Diagram" /></td>
</tr>
<tr>
<td><strong>Time 3</strong></td>
<td><img src="image" alt="Trajectory Diagram" /></td>
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<tr>
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<td><img src="image" alt="Trajectory Diagram" /></td>
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<tr>
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<td><img src="image" alt="Trajectory Diagram" /></td>
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</table>
Overall Mobility (Time 1 to Time 3)

<table>
<thead>
<tr>
<th>Mobility Type</th>
<th>Trajectories</th>
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<tr>
<td></td>
<td>L</td>
</tr>
<tr>
<td>Downward</td>
<td>H</td>
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<td></td>
<td>L</td>
</tr>
<tr>
<td>Upward</td>
<td>H</td>
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<tr>
<td></td>
<td>L</td>
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</table>
## Mobility 1 (Time 1 to Time 2)

<table>
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<th>Trajectories</th>
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<tr>
<td>Stable</td>
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<tr>
<td></td>
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<tr>
<td>Downward</td>
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<td>Upward</td>
<td>H</td>
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<td></td>
<td>L</td>
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<tr>
<td>Mobility Type</td>
<td>Trajectories</td>
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<tr>
<td><strong>Stable</strong></td>
<td><img src="image" alt="Stable Trajectories" /></td>
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<td><strong>Downward</strong></td>
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## Summary of Hypotheses

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<th>SES Risk (T1)</th>
<th>SES Risk (T2)</th>
<th>SES Risk (T3)</th>
<th>Mobility Overall</th>
<th>Mobility 1 (T1- T2)</th>
<th>Mobility 2 (T2 – T3)</th>
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<td>0</td>
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<td>Downward</td>
</tr>
<tr>
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<td>Stable</td>
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</tbody>
</table>
### Examples of Life-Course Results

<table>
<thead>
<tr>
<th>Author</th>
<th>Female</th>
<th>Male</th>
<th>Outcome</th>
<th>SES Indicator</th>
<th>Country</th>
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<tbody>
<tr>
<td>Murray et al., 2011</td>
<td>Accumulation</td>
<td>Childhood sensitive period</td>
<td>CVD</td>
<td>Occupational social class</td>
<td>UK</td>
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<tr>
<td>Mishra et al., 2009</td>
<td>Accumulation</td>
<td></td>
<td>BMI</td>
<td>Manual / non-manual</td>
<td>UK</td>
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<tr>
<td>Gustafsson et al., 2011</td>
<td>Accumulation; Adolescent sensitive period</td>
<td>Accumulation; Current sensitive period</td>
<td>Allostatic load</td>
<td>Occupation</td>
<td>Sweden</td>
</tr>
<tr>
<td>Padyab, et al., 2013</td>
<td>Accumulation</td>
<td>Accumulation</td>
<td>All-cause mortality</td>
<td>SEI, Hollingshead Index of Social Position</td>
<td>Sweden</td>
</tr>
</tbody>
</table>
Specification of Models

• Models were performed separately for females and males.

• The model for each life-course hypothesis is nested within a saturated model.
  • The saturated model provides a different mortality odds ratio for each of the 8 trajectories

• Logistic models were used and the results will be discussed as odds ratios.
Specification of Models

Saturated Model

\[ y = \beta_0 + \beta_1 x_{\text{Asian}} + \beta_2 x_{\text{European}} + \beta_3 x_{\text{Māori}} + \beta_4 x_{\text{Pacific}} + \beta_5 x_{\text{SES1}} + \beta_6 x_{\text{SES2}} + \beta_7 x_{\text{SES3}} + \beta_8 x_{\text{SES1}} x_{\text{SES2}} + \beta_9 x_{\text{SES1}} x_{\text{SES3}} + \beta_{10} x_{\text{SES2}} x_{\text{SES3}} + \beta_{11} x_{\text{SES1}} x_{\text{SES2}} x_{\text{SES3}} \]

<table>
<thead>
<tr>
<th>Restriction on Saturated Model</th>
<th>Degrees of Freedom (DF)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>11</td>
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</tbody>
</table>
Specification of Models

Accumulation Model

\[ y = \beta_0 + \beta_1 x_{\text{Asian}} + \beta_2 x_{\text{European}} + \beta_3 x_{\text{Māori}} + \beta_4 x_{\text{Pacific}} + \beta_5 x_{\text{SES1}} + \beta_5 x_{\text{SES2}} + \beta_5 x_{\text{SES3}} \]

<table>
<thead>
<tr>
<th>Restriction on Saturated Model</th>
<th>Degrees of Freedom (DF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \beta_5 = \beta_6 = \beta_7 )</td>
<td>( \beta_8 = \beta_9 = \beta_{10} = \beta_{11} = 0 )</td>
</tr>
</tbody>
</table>
Specification of Models

Sensitive Period Models

Time 1: $y = \beta_0 + \beta_1 x_{\text{Asian}} + \beta_2 x_{\text{European}} + \beta_3 x_{\text{Māori}} + \beta_4 x_{\text{Pacific}} + \beta_5 x_{\text{SES1}}$

Time 2: $y = \beta_0 + \beta_1 x_{\text{Asian}} + \beta_2 x_{\text{European}} + \beta_3 x_{\text{Māori}} + \beta_4 x_{\text{Pacific}} + \beta_6 x_{\text{SES2}}$

Time 3: $y = \beta_0 + \beta_1 x_{\text{Asian}} + \beta_2 x_{\text{European}} + \beta_3 x_{\text{Māori}} + \beta_4 x_{\text{Pacific}} + \beta_7 x_{\text{SES3}}$

<table>
<thead>
<tr>
<th>Restriction on Saturated Model</th>
<th>Degrees of Freedom (DF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1: $\beta_6 = \beta_7 = \beta_8 = \beta_9 = \beta_{10} = \beta_{11} = 0$</td>
<td>5</td>
</tr>
<tr>
<td>P2: $\beta_5 = \beta_7 = \beta_8 = \beta_9 = \beta_{10} = \beta_{11} = 0$</td>
<td>5</td>
</tr>
<tr>
<td>P3: $\beta_5 = \beta_6 = \beta_8 = \beta_9 = \beta_{10} = \beta_{11} = 0$</td>
<td>5</td>
</tr>
</tbody>
</table>
Specification of Models

Mobility Models

Overall Mobility: \( y = \beta_0 + \beta_1 x_{\text{Asian}} + \beta_2 x_{\text{European}} + \beta_3 x_{\text{Māori}} + \beta_4 x_{\text{Pacific}} + \beta_5 x_{\text{SES1}} + \beta_7 x_{\text{SES3}} + \beta_9 x_{\text{SES1}} x_{\text{SES3}} \)

Mobility 1: \( y = \beta_0 + \beta_1 x_{\text{Asian}} + \beta_2 x_{\text{European}} + \beta_3 x_{\text{Māori}} + \beta_4 x_{\text{Pacific}} + \beta_5 x_{\text{SES1}} + \beta_6 x_{\text{SES2}} + \beta_8 x_{\text{SES1}} x_{\text{SES2}} \)

Mobility 2: \( y = \beta_0 + \beta_1 x_{\text{Asian}} + \beta_2 x_{\text{European}} + \beta_3 x_{\text{Māori}} + \beta_4 x_{\text{Pacific}} + \beta_6 x_{\text{SES2}} + \beta_7 x_{\text{SES3}} + \beta_{10} x_{\text{SES2}} x_{\text{SES3}} \)

<table>
<thead>
<tr>
<th>Restriction on Saturated Model</th>
<th>Degrees of Freedom (DF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall: ( \beta_6 = \beta_8 = \beta_{10} = \beta_{11} = 0 )</td>
<td>7</td>
</tr>
<tr>
<td>Mobility 1: ( \beta_7 = \beta_9 = \beta_{10} = \beta_{11} = 0 )</td>
<td></td>
</tr>
<tr>
<td>Mobility 2: ( \beta_5 = \beta_8 = \beta_9 = \beta_{11} = 0 )</td>
<td></td>
</tr>
</tbody>
</table>
Comparison of Model Fit

Likelihood Ratio Test Statistic / Deviance

\[ D = -2(\ln(\text{likelihood of hypothesised model}) - \ln(\text{likelihood of saturated model})) \]

\[ D \sim \chi^2(\text{df saturated model} - \text{df hypothesised model}) \]

Looking for non-significant results – no evidence against fit
Variables Considered

- Household Income
- Unemployment
- Welfare Receipt
- NZSEI
# Life-Courses Considered

<table>
<thead>
<tr>
<th>Childhood 0-14</th>
<th>Adolesc. 15-24</th>
<th>Early Adulthood 25-44</th>
<th>Middle Adulthood 45-59</th>
<th>Late Adulthood 60+</th>
</tr>
</thead>
</table>

Analysis Group

~5 year death follow up
Household Income Example

The Results
## Household Income Frequencies

<table>
<thead>
<tr>
<th></th>
<th>Female</th>
<th></th>
<th></th>
<th>Male</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>% of total</td>
<td>% died</td>
<td>N</td>
<td>% of total</td>
</tr>
<tr>
<td>H</td>
<td>37,788</td>
<td>69.0%</td>
<td>2.1%</td>
<td>37,302</td>
<td>80.3%</td>
</tr>
<tr>
<td>L</td>
<td>6,393</td>
<td>11.7%</td>
<td>2.8%</td>
<td>3,819</td>
<td>8.2%</td>
</tr>
<tr>
<td>H</td>
<td>1,770</td>
<td>3.2%</td>
<td>2.9%</td>
<td>1,068</td>
<td>2.3%</td>
</tr>
<tr>
<td>L</td>
<td>1,677</td>
<td>3.1%</td>
<td>4.1%</td>
<td>948</td>
<td>2.0%</td>
</tr>
<tr>
<td>H</td>
<td>4,389</td>
<td>8.0%</td>
<td>2.6%</td>
<td>2,403</td>
<td>5.2%</td>
</tr>
<tr>
<td>L</td>
<td>1,509</td>
<td>2.8%</td>
<td>3.6%</td>
<td>444</td>
<td>1.0%</td>
</tr>
<tr>
<td>H</td>
<td>438</td>
<td>0.8%</td>
<td>1.4%</td>
<td>198</td>
<td>0.4%</td>
</tr>
<tr>
<td>L</td>
<td>765</td>
<td>1.4%</td>
<td>4.3%</td>
<td>255</td>
<td>0.5%</td>
</tr>
</tbody>
</table>
Household Income – Female

Odds Compared to Reference

Accumulation

0 1 2 3

Saturated
Accumulation
Household Income – Female

Mobility Overall

Mobility 1

Mobility 2

Odds Compared to Reference

Saturated
Mobility

H
L

H
L

H
L

H
L

H
L

H
L

H
L

H
L

H
L

H
L

H
L
Household Income – Male

Accumulation

Odds Compared to Reference

Saturated
Accumulation
Household Income – Male

Early Adulthood

Middle Adulthood

Late Adulthood

Saturated
Sensitive Period

Odds Compared to Reference
Household Income – Male

Mobility Overall

Mobility 1

Mobility 2

Odds Compared to Reference
Model Fits
## Model Fit Summary

<table>
<thead>
<tr>
<th></th>
<th>Accumulation</th>
<th>Sensitive Period</th>
<th>Mobility</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Household income</strong></td>
<td>Females</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>NZSEI</strong></td>
<td>Females</td>
<td>Females (late adulthood)</td>
<td></td>
</tr>
<tr>
<td><strong>Unemployment</strong></td>
<td>Females</td>
<td>Females (middle adulthood)</td>
<td>Females (early to middle and middle to late adulthood)</td>
</tr>
<tr>
<td><strong>Welfare Receipt</strong></td>
<td></td>
<td>Females (late adulthood)</td>
<td></td>
</tr>
</tbody>
</table>

No models fit as well as the saturated model for males
Conclusions

Implications, Limitations and Next Steps
Conclusions

- Differences by sex in life-course trajectories and hypotheses
- Household income, NZSEI group, unemployment and welfare receipt showed associations with mortality
- Accumulation, certain sensitive periods and some mobility hypotheses fit for females observed at early, middle and late adulthood (variable dependent)
- There was no evidence of a life-course model that was as good as knowing the full life-course trajectory when considering males observed over the same period
Limitations

• Limited to 25 year period
• Census variables do not perfectly represent the variables we wish we could measure
• Premature mortality rare so models using childhood unstable
Next Steps – HRC Grant

HRC Project Aims:
1. Testing life-course hypotheses
2. Protective effects of social and cultural capital
3. Understanding ethnic disparities
4. Testing hypotheses among discordant siblings
Next Steps – My Thesis

• Developing a SES Index and testing life-course hypotheses
• Instability as a life-course hypothesis
• Protective effects of social and cultural capital
• Understanding ethnic disparities
  • Life-course trajectory differences
  • Social and cultural capital differences


Acknowledgements

- COMPASS Team: Barry, Nichola, Martin, Roy, Kevin, Peter
- Past summer scholars in this area: Chris Liu, Rahul Singhal and Vera Puti Puti Clarkson
- Advisor Andrew Sporle
- Statistics New Zealand
- NZCMS

Questions and Comments?