Adjusting for linkage bias in the New Zealand Longitudinal Census

COMPASS Colloquium
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Barry Milne
COMPASS Research Centre
University of Auckland
New Zealand

www.compass.auckland.ac.nz

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Outline

- New Zealand Longitudinal Census (NZLC)
  - Background
  - What is it?
  - How is it being used?
    - Life-course predictors of mortality inequalities
- Linkage Bias
  - What is it?
  - Why is it an issue with the NZLC?
  - Can we adjust for it?
- Conclusions
NZLC - Background

- Census covers whole population, but is cross-sectional snapshot in time
- Greater understanding of time trends and social processes if Census had longitudinal component
  - What is the extent of ethnic mobility and what factors explain changing ethnic identification?
  - Is geographical mobility increasing in NZ
  - What are the long term consequences of poverty?
- Possible if could link records across Censuses
  - Other countries (UK, Australia) have linked Censuses

- ‘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)
- 70-76% linkage (approx 3% probabilistic) between adjacent Censuses
- 15 cohorts altogether
  - Joining links of adjacent Censuses
## NZLC - What is it?

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Description and assessment of bias
- COMPASS, Stats NZ (Kirsten Nissen, Robert Didham, Wendy Dobson)

Ethnic mobility
- Robert Didham

Life-course predictors of mortality inequalities
- COMPASS, StatsNZ, UOW (Tony Blakely, June Atkinson) - HRC funded
- Link between NZLC and NZ Census Mortality Study, allowing assessment of socio-economic risk factors in (up to) 25 years leading up to death.
Linkage Bias - What is it?

A specific type of 'selection bias' (as it concerns us)

- Those selected (linked) differ from those unable to be linked
- X-Y associations in the selected sample differ from X-Y associations in the full sample
  - i.e., associations are biased by selection

![Diagram of X and Y connected to S]
Linkage Bias
- Why an issue with NZLC?

- There is incomplete linkage between Censuses
  - 31%-75% of theoretical population linked, depending on the cohort

- Linkage varies as a function of various factors
  - Age, Sex, Residential mobility, Deprivation, Relationship Status, Housing Tenure, Ethnicity

- With so many factors associated with linkage, it is possible that biased measures of association will be obtained

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

- CAN’T assess full extent of bias for longitudinal associations
  - 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 - Why an issue with NZLC?

- Assessed 2-way (X-Y) correlations between 30 (children) & 44 (adult) variables for
  - Full (linkable) Census in 2006; Sample linked from 2006 to 2001
  - Assess magnitude of difference between two sets of correlations

**Children aged 5-14**

- Proportion of correlations
- Magnitude difference between linked and full Census correlations
- 54%

**Adults, aged 15+**

- Proportion of correlations
- Magnitude difference between linked and full Census correlations
- 41%
Linkage Bias - Can we adjust for it?

- Calculated each individual's propensity to be linked, based on their characteristics
  - Logistic regression model including main effects only
- Weighted by inverse of these propensities in analyses (as per AusLC)

**Children aged 5-14**

- Unweighted: 68%
- Weighted - Main effects: 57%

**Adults, aged 15+**

- Unweighted:
- Weighted - Main effects: 57%
Linkage Bias
-Can we adjust for it?

- Calculated each individual's propensity to be linked, based on their characteristics
  - logistic regression model including main effects and interactions
- Weighted by inverse of these propensities in analyses (as per AusLC)

**Children aged 5-14**

- 73% difference

**Adults, aged 15+**

- 58% difference
Linkage Bias
- Can we adjust for it?

⚠️ Initial attempts suggest we can reduce bias but not eliminate it
   - Only tried one cohort with one approach
   - Other approaches being considered – tree regression

⚠️ Suggestion that associations less affected by bias with covariates controlled
   - Might this help with NZLC data?
   - Worked example: regress income against sex, age, ethnicity, deprivation, education (adults aged 20-69)
# Linkage Bias
-Can we adjust for it?

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<th>Age Group</th>
<th>Full</th>
<th>Linked</th>
<th>Weighted</th>
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<td>25-29</td>
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<td>65-69</td>
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### Diagram

- **Full**
- **Linked**
- **Weighted**

![Graph showing % discrepancy vs Age](image-url)
Linkage Bias
-Can we adjust for it?

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Linkage Bias
-Can we adjust for it?

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Linkage Bias
-Can we adjust for it?

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Conclusions

- Selection bias as a result of linkage seems a real concern with the NZLC
  - Some association greatly affected; others less so
  - Unadjusted associations more affected than covariate-adjusted associations (one example)

- Early attempts at weighting reduced bias but did not remove it
  - Different cohorts will be examined
  - Different approaches can be tried – Any suggestions?
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
- Others: Tony Blakely, June Atkinson, Andrew Sporle, Alan Lee
Extra linkage to mortality will make bias adjustment even harder

- Never sure whether missed mortality links are in theoretical population or not
- If 200 (in a cell) died 2006-2011 and 150/200 linked to 2006 record, these are weighted 200/150 for NZCMS
- Can never be sure whether missed 50 belong to theoretical population able to be linked back to 2001 (i.e., had been in country for at least 5 years)
  - Might estimate from unlinked proportion of cell in theoretical population.