Income dynamics and adult mortality in Canada and the United States

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Institute for Work & Health
Plenary series

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Project history

- PhD Dissertation, Epidemiology, University of Toronto
- September 2009
- Supervisor: Cameron Mustard
- Committee: Doug Manuel & William Gnam
Outline

1. Introduction

2. Study 1: Income drops and mortality in the US and Canada

3. Study 2: Income drops and mortality in Canada: evidence of causality

4. Summary
Outline

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Study aims

- Does income level determine adult mortality?
- Do income drops determine adult mortality?
- Are the effects of income level and income drops the same in Canada and the US?

Who cares?
- Income level: policies on distribution of income & health
- Income drops: policies on labour market flexibility & income security
- Canada v US: which country better protects the health and income security of its residents?
What we know about income & adult mortality

- Greater income is associated with lower mortality.
  - True for men and women.
  - True throughout working life.
  - True in Canada and the US.

- Income drops may be associated with greater mortality.
  - Unemployment
    - Usually associated with increased mortality
  - Involuntary job loss
    - Often associated with increased mortality
  - Income drops
    - May increase mortality only at middle income levels
Equivalized family income & mortality by age and sex
What we don’t know about income & adult mortality

- Income level
  - Role of health selection
  - Importance for mortality in Canada v US

- Income drops
  - Is the US finding statistically robust?
  - Is the US finding reproducible in Canada?
  - Elements of causal inference:
    - Strength of association?
    - Dose response?
    - Biologically plausible induction times?
    - Economically plausible dependency on income level?
    - Health selection?
    - Confounding?
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Replicating McDonough et al. 1997
Income drops increased mortality only at middle income levels

Questions:
Does US finding depend on the statistical method?
Is effect of income level similar in Canada & US?
Is effect of income drops similar in Canada & US?
Does the effect of drops depend on level in Canada & US?
Canada v USA: Methods

- **Data:**
  - Canada: tax data (1982-2005)
  - Ages 45-64 at baseline

- **Analysis:**
  - McDonough et al.: logistic regression
  - New analyses: Cox regression
  - Adjusted for age, sex, family size & black v white (US only)
Canada v USA: Results

<table>
<thead>
<tr>
<th></th>
<th>LAD (Canada)</th>
<th></th>
<th>PSID (US)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Age (baseline, t-5)</td>
<td>49.1</td>
<td>6.1</td>
<td>49</td>
<td>4.7</td>
</tr>
<tr>
<td>Family size (5y mean)¹</td>
<td>2.8</td>
<td>1.2</td>
<td>3.4</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td>Freq</td>
<td>%</td>
<td>Freq</td>
<td>%</td>
</tr>
<tr>
<td>Died</td>
<td>40,180</td>
<td>6.9</td>
<td>341</td>
<td>13.8</td>
</tr>
<tr>
<td>Male</td>
<td>311,795</td>
<td>53.3</td>
<td>805</td>
<td>46.3</td>
</tr>
<tr>
<td>Black</td>
<td>NA</td>
<td>NA</td>
<td>168</td>
<td>9.7</td>
</tr>
<tr>
<td>Drops (5y cum. incidence)¹</td>
<td>160,950</td>
<td>31.2</td>
<td>227</td>
<td>13.4</td>
</tr>
<tr>
<td>Income Level (5y mean, 1993 USD)¹</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 20,000 (low)</td>
<td>113,130</td>
<td>21.9</td>
<td>287</td>
<td>16.9</td>
</tr>
<tr>
<td>20,000-70,000 (middle)</td>
<td>317,230</td>
<td>61.4</td>
<td>1067</td>
<td>62.9</td>
</tr>
<tr>
<td>&gt; 70,000 (high)</td>
<td>86,295</td>
<td>16.7</td>
<td>342</td>
<td>20.2</td>
</tr>
</tbody>
</table>

¹ During first 5y period.
Interaction of income drops & income level

<table>
<thead>
<tr>
<th>Income Drops</th>
<th>Canada (Cox)</th>
<th>US (Cox)</th>
<th>US (Logistic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low + drops</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middle + drops</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High + drops</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hazard Ratio

Hazard Ratio

Odds Ratio
Under-ascertainment of deaths in Canadian tax data

- Mortality rates in tax data are 73% of official estimates
- Under-ascertainment could be differential by income level

<table>
<thead>
<tr>
<th></th>
<th>Rich</th>
<th>Poor</th>
<th>RR</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.7</td>
<td>0.7</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>0.8</td>
<td>0.6</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>0.9</td>
<td>0.5</td>
<td>2.2</td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td>0.4</td>
<td>1.6</td>
<td></td>
</tr>
</tbody>
</table>
Under-ascertainment of deaths in Canadian tax data

- 1991 Census mortality follow-up allows comparison
- Under-ascertainment may not be differential by income level

<table>
<thead>
<tr>
<th>Sample</th>
<th>Age</th>
<th>Sex</th>
<th>RR: Q5/Q1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>45-64</td>
<td>M+F</td>
<td>2.3</td>
</tr>
<tr>
<td>Low + Drops</td>
<td>45-64</td>
<td>M+F</td>
<td>1.9</td>
</tr>
<tr>
<td>Census</td>
<td>45-54</td>
<td>M</td>
<td>2.5</td>
</tr>
<tr>
<td>Census</td>
<td>45-54</td>
<td>F</td>
<td>2.3</td>
</tr>
<tr>
<td>Census</td>
<td>55-64</td>
<td>M</td>
<td>2.2</td>
</tr>
<tr>
<td>Census</td>
<td>55-64</td>
<td>F</td>
<td>2.0</td>
</tr>
</tbody>
</table>
Canada v USA: Discussion

Findings:

- Does US finding depend on the statistical method?
  - No.

- Is effect of income level similar in Canada & US?
  - No, the effect is greater in the US.

- Is effect of income drops similar in Canada & US?
  - No, effects are smaller in Canada.

- Does the effect of drops depend on level in Canada & US?
  - Yes. In Canada effect protective for poor. In US limited to middle incomes.
# Outline

1. Introduction

2. Study 1: Income drops and mortality in the US and Canada

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Study 2: Introduction

- Canada only
- Questions on income level:
  - Health selection?
- Questions on income drops:
  - Strength of association?
  - Dose response?
  - Biologically plausible induction times?
  - Economically plausible dependency on income level?
  - Health selection?
  - Confounding?
    - Family structure changes
    - Retirement
    - Family death
    - Self-employment
Study 2: Methods

Data:
- Canada: tax data (1982-2005)
- Ages 40-55 at exposure
- Lag 1-18 years between exposure and death
- Deaths at age 41-73

Analysis:
- Cox regression
- Adjusted for age
- Exclusion: recent immigrants, missing income data
- Models with and without work disability and other confounding variables
- Separate models for each lag, sex, family type combination
  - \( \text{lag (18)} \times \text{sex (2)} \times \text{family type (2)} \times \text{subsets (7)} \times \text{drops (2)} = 1008 \text{ regressions} \)
- also main effects, additive, interactions
- also full data and 1992+ data
Study 2: Results

- Results for men in couple families
- Deaths/model: range = 1,390 to 16,980
**Study 2: Distribution of projected income drops**

- Projected drops more common than annual drops (not shown)
- Some “regression to mean:” small drops for rich
- But poor more likely to experience largest drops

<table>
<thead>
<tr>
<th>Income Drops</th>
<th>Income level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Poor</td>
</tr>
<tr>
<td>None</td>
<td>57.9</td>
</tr>
<tr>
<td>(0-15%)</td>
<td>18.9</td>
</tr>
<tr>
<td>(15-50%)</td>
<td>17.1</td>
</tr>
<tr>
<td>(50-100%)</td>
<td>6.1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100</td>
</tr>
</tbody>
</table>
Study 2: Effect of income level adjusting for income drops
Study 2: Effect of income level & confounding

Introduction

HR (compared to richest tertile; log scale)
1.25
1.5
Years between exposure and outcome
HR (compared to richest tertile; log scale)
1
1.25
1.5
5 10 15
Tertile
●● Middle
●● Poor
Type
●● Projected
Annual
# Study 2: Effect of income drops (all exclusions)

<table>
<thead>
<tr>
<th>Years between exposure and outcome</th>
<th>HR (compared to no drop; log scale)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0–15]</td>
<td>0.8</td>
</tr>
<tr>
<td>(15–50]</td>
<td>1</td>
</tr>
<tr>
<td>(50–100]</td>
<td>1.25</td>
</tr>
</tbody>
</table>

- **Type**
  - Projected
  - Annual

![Graph showing the effect of income drops over years between exposure and outcome](image)

- **Years between exposure and outcome**
- **HR (compared to no drop; log scale)**
Study 2: Effect of income drops & confounding

Introduction

Study 1

Study 2

Summary
Study 2: Interaction between income drops & income level

TYPE3 tests for PROC TPHREG effect of interaction term
Questions on income level:

- Is health selection the principle pathway?
  - No. Little decay in effect argues against health selection.
  - No. Effect of income level not greater among those with income drops, regardless of induction times.
Study 2: Discussion: income drops

Questions on income drops:
- Strength of association?
  - Small for causal inference. Substantial for population burden.
- Dose response?
  - Yes, for men in couple families.
- Biologically plausible induction times?
  - Maybe not: enduring effect of acute exposure.
- Economically plausible dependency on income level?
  - No.
- Health selection?
  - Effect persists, but residual confounding possible.
- Confounding by family structure changes, retirement, family death, self-employment
  - Effect persists.
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What these studies add

- Income level is a strong determinant of mortality, and the effect is primarily causal.
- Income drops are associated with increased mortality, but evidence for causality is mixed.
- Income level likely has a stronger effect on mortality in the US than in Canada.
- Income drops have not been shown to have a similar effect in the US and Canada.
Study strengths

- **LAD**: generalizability, sample size, longitudinal, low loss to follow-up
- **LAD/PSID**: death as outcome
- **LAD/PSID**: high quality annual family income data by component
- **LAD/PSID**: spans several business cycles
- **LAD**: examination of relevant induction times
- **LAD**: differences by sex & family type
- **LAD**: control for important sources of confounding
- **PSID**: survey follow-up of death events
Study weaknesses

- LAD: underascertainment of death events
  - more likely at lower income
  - misclassification bias (to null)
- LAD: no data on occupation, education, health status (confounding bias)
- LAD: no data on cause of death
- PSID: sample size
- PSID: sample pre-dates recent Hispanic immigration
- LAD v PSID: samples not entirely comparable
- LAD v PSID: uncontrolled confounding
Acknowledgements

- Support
  - Hung Pham, Jeffrey Smith, Andre Bérnard (Statistics Canada)
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