Age-period-cohort analysis of obesity rates among off-reserve Aboriginal Peoples

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Aboriginal Peoples

• Aboriginal peoples in Canada totals over 1.4 million and comprise the First Nations, Inuit and Métis
• Aboriginal population is young and growing: about 30% is under 15, compared to 18% of the total Canadian population
• About 60% of Aboriginal people live outside of discrete Aboriginal communities
Obesity Epidemic

- The health status of Aboriginal peoples is poorer than that of non-Aboriginal Canadians
- Obesity among Aboriginal people is a particular concern: as many as half of all Aboriginal children and youth are classified as overweight or obese
- Childhood obesity is associated with a variety of physical, emotional and social consequences in childhood, adolescence and adulthood
Program of Research

• To improve health of Aboriginal children and youth
• To identify the factors affecting obesity among Aboriginal children living in off-reserve areas
• To develop and test culturally-appropriate ‘healthy weights’ interventions
• Research activities: Literature reviews, analysis of secondary data, surveys, focus groups, program evaluation
Healthy Weights Connection

- Working Together to Promote the Health of First Nations and Metis Children in our Communities
- This public health system-level intervention strives to improve existing community resources and access new resources to achieve and maintain healthy weights among Aboriginal children and youth
- Funded by Public Health Agency of Canada’s Innovation Strategy
- http://www.healthyweightsconnection.ca
Evaluation of Obesity Interventions

- Are they applicable in all cultural and geographic contexts?
- Are they effective in general?
- Are they effective for children and youth of all ages?
- Are they suitable to children and youth born at different time periods?
Trends in Obesity Rates

• Age effects – As we age, we are more likely to become overweight and obese
• Period effects – Secular changes in diet and physical activity across time are generally thought to be the root of the current obesity epidemics
• Cohort effects – Birth cohort membership may also have some effect on overweight and obesity rates
Cohort Effects

• Rapid social and environmental changes over recent decades have meant that successive birth cohorts have grown up in decidedly different social, technological, and physical environments.

• Changed environments affect not only diets and physical activities, but also expectations and preferences with regard to lifestyles, social activity, and other factors that indirectly affect risk of overweight and obesity.

• Aboriginal children experience more rapid social change.
Study Objectives

• Understanding the reasons for changing obesity rates among Aboriginal children and youth requires the careful attention to age, period and cohort effects.

• The objective of this study was to conduct an exploratory analysis of age, period and cohort effects on weight status among Aboriginal children and youth.
Data and Sample

- Age: 12 – 39
- Exclusion criteria: data provided by proxy respondents; pregnant and/or breastfeeding at the time of interview; missing data
- In total, 252,064 respondents; 6.3% respondents identified themselves as First Nations, Intuits and Métis
Measurement: Age and Period

- Age – Continuous scale
- Period – Based on the year when the CCHS data were collected, six time periods were identified, 2001, 2003, 2005, 2007/2008, 2009/2010 and 2011/2012
- Cohort – 17 birth cohorts were identified, based on respondents’ age and the year when the CCHS data were collected: 1964/1965 to 1996/1997
Measurement: Weight Status

- Self-reported height and weight
- Weight status was assessed by a binary variable indicating whether respondents were overweight or not
- BMI > 25; adjusted by age and sex
Challenges in Assessing A-P-C Effects

- APC analysis is not a specific statistical technique but a general strategy for analyzing data
- Identification problem:
  - Exact linear dependency between age, period, and cohort
  - Period = Cohort + Age
- Impossible to estimate all three effects at the same time
- “a futile quest” (Glenn, 1976)
Traditional Solutions

- Age-by-time period contingency tables
- Graphical display of trends:
  - Age-period-specific rates
  - Age-cohort-specific rates
Overall Age Effect

% Overweight


Aboriginal  Non-Aboriginal

Schulich  Western
Overall Period Effect

The graph illustrates the percentage of overweight individuals among Aboriginal and non-Aboriginal populations over the periods 2001 to 2011/2012.

- **Overweight Aboriginal**
- **Overweight Non-Aboriginal**
Age-Period-Specific Effect – Aboriginal

<table>
<thead>
<tr>
<th>Age Group</th>
<th>% Overweight 2001</th>
<th>% Overweight 2005</th>
<th>% Overweight 2011/12</th>
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<td>38-39</td>
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</tbody>
</table>
Age-Period-Specific Effect – Others

% Overweight

Age-Cohort-Specific Effect – Aboriginal

% Overweight


Aboriginal: 1968/1969
Aboriginal: 1974/1975
Aboriginal: 1980/1981
Aboriginal: 1986/1987
Aboriginal: 1992/1993
Age-Cohort-Specific Effect – Others

% Overweight


- Non-Aboriginal: 1968/1969
- Non-Aboriginal: 1974/1975
- Non-Aboriginal: 1986/1987
- Non-Aboriginal: 1992/1993
Limitations of Traditional Solutions

• Graphical display of trends are interesting and suggestive
• However, age, period and cohort effects have to be assessed simultaneously to produce conclusive results
Statistical Model - Mason et al, 1973

- Recode Age, Period and Cohort variables into dummy variables usually representing a range of 5-10 years
- Omit of one dummy variable for Age, Period or Cohort to break the linear dependency in the statistical model (equal effect assumption)
- Done!
Simulation Study

- Simulation study
- 5 point per 10 years positive period effect
- 5 point negative cohort effect
Hierarchical APC Analysis

- Developed by Yang and Land (2006), this conceptually attractive technique claims to resolve the model identification problem of the classic APC analysis.
- Application of techniques developed for cross-classified random-effects hierarchical (multi-level/random-effects/mixed) models (CCREM) to repeated survey data.
- Individual level observations are nested within birth cohorts and time periods.
Advantages of HAPC Analysis

- Period
- Cohort
  - Individual (Age)

- Country
- Cohort
  - Period
  - Individual
    - Occasion (Age)
Hierarchical APC Analysis

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Unconditional HAPC Model

- Level one model:
  \( Y_{ijk} = \beta_{0jk} + r_{ijk} \)
- Level two model:
  \( \beta_{0jk} = \gamma_{00} + u_{0j} + v_{0k} \)
- Combined model:
  \( Y_{ijk} = \gamma_{00} + u_{0j} + v_{0k} + r_{ijk} \)
HAPC Model for Overweigh

• Level one model (for binary outcome):
  • Overweight_{ijk} = \beta_{0jk} + \beta_1 \text{Age}_{ijk} + \beta_2 \text{Age}^2_{ijk} + \beta_3 \text{Aboriginal}_{ijk} + \beta_4 \text{Sex}_{ijk} + \beta_5 \text{Interview Mode}_{ijk}

• Level two model:
  • \beta_{0jk} = \gamma_{00} + u_{0j} + v_{0k}
Random Effects

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Aboriginal</th>
<th>Non-Aboriginal</th>
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<tbody>
<tr>
<td>Null Model</td>
<td>0.0787</td>
<td>0.0965</td>
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<tr>
<td>Adjusted Model</td>
<td>0.0085</td>
<td>0.0033</td>
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<tr>
<td>Cohort</td>
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<tr>
<td>Null</td>
<td>0.6041</td>
<td>0.4693</td>
</tr>
<tr>
<td>Adjusted</td>
<td>0.0003</td>
<td>0.0013</td>
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</tbody>
</table>

- Inclusion of the age and other level one predictors accounted for the cohort variance
HAPC: Age Effect

% Overweight


- Aboriginal: GLIMIX
- Aboriginal: Descriptive
- Non-Aboriginal: GLIMIX
- Non-Aboriginal: Descriptive
HAPC: Period Effect

Odds of Overweight

- Aboriginal
- Average
- Non-Aboriginal
HAPC: Cohort Effect

Odds of Overweight

Non-Aboriginal  Average  Aboriginal
Conclusions on APC Analysis

• Descriptive statistics suggested that period and cohort effects may play some roles in explaining increasing obesity rates among children and youth
• The results of HAPC analysis indicated that the period and cohort effects are not significant
Limitations of Statistical Models

- Recent simulation studies indicate that HAPC analysis can arbitrarily reapportion APC effects.
- There is no statistical solution to the identification problem without strong a priori assumption … which may be incorrect.
- APC effects are confounded in the population: “…this dependency lies not with the model that is fitted to the data nor with the data itself, but with the underlying processes that created the data” (Bell & Jones, 2014).
- “All models are wrong, but some are useful” (Box & Draper, 1987).