Linked health data: New research opportunities for health information

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Delivering insight through data for a better Canada
Statistics Canada Modernization -
Data Integration key to the future

Moving beyond a survey-first approach with
new methods and integrating data from a
variety of existing sources

Making data easier to access and use by adopting
new tools to analyze and visualize data

Enabling Canadians to use data to
make evidence-based decisions

Enabling efficient data management and access
Population Health Data @StatCan

- Equity
- Health Behaviours
- Outcomes
- Social Determinants
- Environment
- Health Behaviours
- Physical activity
- Socio-economic status
- Poverty
- Housing
- Education
- Employment
- Mortality
- Cancer
- Hospital use
- Gender
- Socio-economic status
- Ethnicity
- Environment
- Geography
- Equity

Across the life cycle
Social Data Linkage Environment (SDLE)

- Secure virtual linkage environment that stores only personal identifiers.
- SDLE is NOT a large integrated data base of survey information about individuals.
- Strong governance, adherence to policy and privacy requirements - Directive on Microdata Linkage.
- Suite of services, tools and support for analysts and external researchers.

https://www.statcan.gc.ca/eng/sdle/index
Canadian Census Health and Environment Cohorts (CanCHECs)
What are the CanCHECs?

Population-based linked datasets that follow the non-institutional population (long-form) at time of census for different health outcomes.

- Mortality
- Hospitalization
- Cancer
Why the CanCHECs?

National health administrative data lack socio-economic and ethno-cultural identifiers beyond basic demographic data.

Census data (long-form) contain detailed socio-economic and ethno-cultural information.
Putting them together enables us to examine administrative health outcomes across many characteristics including income, education, occupation, language, ethnicity, First Nations, Métis, Inuit, and immigration.
The CanCHEC cohorts

- 1991 Cohort
- 1996 Cohort
- 2001 Cohort
- 2006 Cohort
- 2011 Cohort*
- 2016 Cohort

*will be available in Spring 2019
The CanCHEC cohorts

- 1991 Cohort
- 1996 Cohort
- 2001 Cohort
- 2006 Cohort
- 2011 Cohort*
- 2016 Cohort

Age of cohort members:
- 1991: 25 or older
- 1996: 19 or older
- 2001: 19 or older
- 2006: 0 or older
- 2011: 0 or older
- 2016: 0 or older

*will be available in Spring 2019

http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&amp;SDDS=3901
The CanCHEC cohorts

1991 Cohort (1981-2016)
1996 Cohort (1981-2016)
2001 Cohort (1981-2016)
2006 Cohort (1981-2016+)
2011 Cohort* (1981-2016+)
2016 Cohort

Years of mailing address postal codes

1991

*will be available in Spring 2019
The CanCHEC cohorts

1991 Cohort
1996 Cohort
2001 Cohort
2006 Cohort
2011 Cohort*
2016 Cohort

Years of mortality data
(Canadian Vital Statistics Death Database)

1991


1991-2016
1996-2016
2001-2016
2006-2016
2011-2016
2016

The CanCHEC cohorts

1991 Cohort
1996 Cohort
2001 Cohort
2006 Cohort
2011 Cohort*
2016 Cohort

Years of cancer data (Canadian Cancer Registry)

1991
1992-2015
1992-2015
1992-2015
1992-2015
1992-2015

http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&amp;SDDS=3207
The CanCHEC cohorts

1991 Cohort

1996 Cohort

2001 Cohort

2006 Cohort

2011 2000/01 – 2016/17 Cohort*

2016 Cohort

Years of hospitalization data (Discharge Abstract Database)

1991

The CanCHEC cohorts

- 1991 Cohort
- 1996 Cohort
- 2001 Cohort
- 2006 Cohort
- 2011 2002/03 – 2016/17 Cohort*
- 2016 Cohort

Years of hospitalization data (National Ambulatory Care Reporting System)
1991

Important features of the CanCHECs

- Household population
- Cohort weights
- Bootstrap weights
- Users create their own analytical cohort file (keys are provided)
Strengths of the CanCHECs

- Consistent linkage methodology
- Can examine trends over time
- Linked at individual level
- Follow-up extended periodically
- New outcomes added
How can the CanCHECs be used?

Population groups
- Immigrant
- First Nations, Métis, Inuit
- Visible minority

Exposures
- Air pollution
- Ultraviolet radiation
- Greenness
- Community

Socioeconomic status
- Education
- Income
- Occupation
- Housing

Effects
- Mortality
- Hospitalization
- Cancer
How *have* the CanCHECs been used?

*Trends in mortality inequalities*

**Population groups**
- Immigrant
- First Nations, Métis, Inuit
- Visible minority

**Socioeconomic status**
- Education
- Income
- Occupation
- Housing

**Exposures**
- Air pollution
- Ultraviolet radiation
- Greenness
- Community

**Mortality**

**Hospitalization**

**Cancer**
All-cause mortality has declined over time but education-related inequalities have increased among women aged 25 or older.

All-cause mortality has declined over time but education-related inequalities have increased among women aged 25 or older

Mortality rate ratio between less than secondary and university degree or above

1991: 1.4 (95% CI 1.2, 1.7)
1996: 1.5 (95% CI 1.4, 1.6)
2001: 1.6 (95% CI 1.5, 1.6)
2006: 1.7 (95% CI 1.6, 1.7)
2011: 1.8 (95% CI 1.8, 1.9)

How have the CanCHECs been used?

Disparities in life and health expectancies

Population groups
- Immigrant
- First Nations, Métis, Inuit
- Visible minority

Exposures
- Air pollution
- Ultraviolet radiation
- Greenness
- Community

Socioeconomic status
- Education
- Income
- Occupation
- Housing

Mortality

Hospitalization

Cancer

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There is a gradient in life expectancy and health-adjusted life expectancy at age 25 among men by level of education within and across income quintiles.

Note: E1=less than secondary graduation; E2=secondary graduation; E3=postsecondary diploma or certificate; E4=university degree; Q1=1st (lowest) income adequacy quintile; Q2=2nd quintile; Q3=3rd quintile; Q4=4th quintile; Q5=5th (highest) income adequacy quintile.

Source: Bushnik T, Tjepkema M, Martel L. Socioeconomic disparities in life and health expectancy among the household population in Canada. *Health Reports (under review).*
How *have* the CanCHECs been used?

**First Nations, Métis, Inuit life expectancy**

**Population groups**
- Immigrant
- First Nations, Métis, Inuit
- Visible minority

**Exposures**
- Air pollution
- Ultraviolet radiation
- Greenness
- Community

**Socioeconomic status**
- Education
- Income
- Occupation
- Housing

**Outcomes**
- Mortality
- Hospitalization
- Cancer

*Delivering insight through data for a better Canada*
Life expectancy for the male First Nations, Métis, and Inuit household population was significantly lower than for the non-Indigenous at all ages in 2011.

How have the CanCHECs been used?

Opioid poisoning hospitalizations

2011 National Household Survey (NHS)

Population groups
- Immigrant
- First Nations, Métis, Inuit
- Visible minority

Socioeconomic status
- Education
- Income
- Occupation
- Housing

Mortality

Hospitalization
Age-standardized rates of hospitalization due to opioid poisonings were 3 times higher among parents and children in lone-parent households compared to those who were married or had a common-law partner (with or without children).

Considerations when using the CanCHECs

- Population exclusions
  - Under age 1 mortality bias
  - 2011 NHS Collective dwellings not in scope

- Change over time in census variables

- No information on health behaviours

- Census characteristics at baseline only
Canadian Community Health Survey (CCHS) linked to hospital, mortality data, and historical postal code files
What are linked Canadian Community Health Survey (CCHS) data?

CCHS is a nationally representative cross-sectional sample survey of the household population (non-institutional) - linked to different health outcomes.

hospitalization

mortality

historical postal codes

What are linked Canadian Community Health Survey data?

Health determinant behaviours
- Smoking
- Physical activity
- Body mass index

Socioeconomic status
- Education
- Income
- Occupation
- Housing

Population groups
- Immigrant
- First Nations, Métis, Inuit
- Visible minority

Hospitalization

Mortality

Historical PostCodes (2000-2016)
### What are these hospital data from CIHI?

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>demographic, administrative and clinical data for acute care, some psychiatric, chronic rehabilitation and day surgery hospital discharges.</td>
<td>demographics, visits to for ambulatory care: day surgery, emergency department, diagnostic imaging, ambulatory clinic visits (e.g. oncology care; clinical information (diagnoses, surgical interventions), administrative financial service-data.</td>
</tr>
</tbody>
</table>

**Ontario Mental Health Reporting System (OHMRS) 2005/2006 to 2017/2018:**
- Implemented in 2005 by CIHI on behalf of the **Ontario Ministry of Health and Long-term Care (MOHLTC)**
- Admissions to designated adult inpatient mental health beds and specialty facilities in Ontario, and these services outside of Ontario that voluntarily submit records to OHMRS
- Mandated in Ontario in 2005 thus since 2005 considered census of individuals admitted to these services for Ontario.
Why link the CCHS to mortality and/or hospital records?

Nationally representative sample of Canadians with health status, health condition, lifestyle factors and socio-economic characteristics

Hospital data contain diagnostic and intervention information for in-patient visits; Mortality data contain timing and cause of death
Why link the CCHS to mortality and/or hospital records?

Putting them together enables us to examine the impact of a broad range of social determinants of health (i.e. socioeconomic status, ethnicity, risk factors and disease states) on health outcomes.
The CCHS by cycle (Annual and Focus surveys)

- CCHS 2000/2001 (cycle 1.1)
- CCHS 2002 (1.2 Mental Health and Well-being)
- CCHS 2003 (cycle 2.1)
- CCHS 2004 (2.2 Nutrition)
- CCHS 2005 (cycle 3.1)
- CCHS 2007 (cycle 4.1)
- CCHS 2007-2008
- CCHS 2008/2009 (Healthy Ageing)
- CCHS 2009/2010
- CCHS 2010
- CCHS 2011
- CCHS 2012 (Mental Health and well-being)
- CCHS 2013
- CCHS 2014
- CCHS 2015 (Nutrition)
- CCHS 2016
- CCHS 2017
The CCHS sample that consented to linkage, by cycle (over 80%)

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCHS 2000\2001 (cycle 1.1)</td>
<td>119,434</td>
</tr>
<tr>
<td>CCHS 2003 (cycle 2.1)</td>
<td>114,288</td>
</tr>
<tr>
<td>CCHS 2005 (cycle 3.1)</td>
<td>115,398</td>
</tr>
<tr>
<td>CCHS 2007\2008 (cycle 4.1)</td>
<td>114,078</td>
</tr>
<tr>
<td>CCHS 2009</td>
<td>53,106</td>
</tr>
<tr>
<td>CCHS 2010</td>
<td>52,828</td>
</tr>
<tr>
<td>CCHS 2011</td>
<td>53,629</td>
</tr>
<tr>
<td>CCHS 2012 (Mental Health and Well-being)</td>
<td>51,980</td>
</tr>
<tr>
<td>CCHS 2013</td>
<td>54,179</td>
</tr>
<tr>
<td>CCHS 2014</td>
<td>52,898</td>
</tr>
<tr>
<td>CCHS 2015</td>
<td>49,329</td>
</tr>
<tr>
<td>CCHS 2016</td>
<td>53,908</td>
</tr>
<tr>
<td>CCHS 2017</td>
<td>55,739</td>
</tr>
</tbody>
</table>

2000/2001
Linked CCHS to hospital data

Years of hospitalization data

Discharge Abstract Database (DAD)
1999/00-2017/18

Annual CCHS 2000-2001 to 2017
Focus: Mental Health 2002 and 2012,
Nutrition 2004 and 2015
Healthy Aging 2008/2009)

April 1, 1999 to ........................................ March 31, 2018

2000/2001 to ........................................ 2017
Linked CCHS to hospital data

Years of hospitalization data

National Ambulatory Care Reporting System (NACRS)
2002/03 - 2017/18

Annual CCHS 2000-2001 to 2017

2000-2001 to .............................................. 2017
April 1, 2002 to ................................. March 31, 2018

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Linked CCHS to hospital data

Years of hospitalization data
Ontario Mental Health Reporting System (OHMRS)
2006/07-2017/18

Annual CCHS 2000-2001 to 2017

2000-2001 to ........................................ 2017
April 1 2006 to .......................... March 31, 2018
Linked CCHS to mortality data

Years of mortality data
Canadian Vital Statistics Database: Deaths
2000-2017

Annual CCHS 2000-2001 to 2017
Focus: Mental Health 2002 and 2012,
Nutrition 2004 and 2015
Healthy Aging 2008/2009)

2000-2001 to........................................2017

Jan.1 2000 to.......................December 31, 2017
Linked CCHS to Historical Postal Code Files

Years of mailing address postal codes
2000-2016

Annual CCHS 2000-2001 to 2017
Focus: Mental Health 2002 and 2012,
Nutrition 2004 and 2015
Healthy Aging 2008/2009)

2000-2001 to ............................................ 2017

2000 to ..................................................... 2016
Population groups
- Immigrant
- First Nations, Métis, Inuit
- Visible minority

Health determinant behaviours
- Smoking
- Physical activity
- Body mass index

Socioeconomic status
- Education
- Income
- Occupation
- Housing

How can linked CCHS to Mortality, DAD be used?

Hospitalization

Mortality
How have linked CCHS to Mortality, DAD been used?

Nutritional risk, hospitalization and mortality among community dwelling Canadians aged 65 or older

by Pamela L. Ramage-Morin, Heather Gilmour and Michelle Rotermann

Available at: https://www150.statcan.gc.ca/n1/en/pub/82-003-x/2017009/article/54856-eng.pdf?st=hODS0b_T
How *have* linked CCHS to Mortality, DAD been used?

**Nutritional Risk Among Seniors – the issues, the need to know**

- 34% of seniors at nutritional risk 2008/2009
- Negative health outcomes of nutritional risk – functional limitations, declines in quality of life, longer hospital stays, death
- Previous studies investigating association between nutritional risk and hospitalization or mortality – small non-representative samples

CCHS-Health Aging Survey (2008) linked to hospital and death data:
- **Is nutritional risk associated with increased risk of acute care hospitalization or death?**
Nutritional risk, hospitalization and mortality among community-dwelling Canadians aged 65 or older

Acute care hospitalization
Nutritional risk, hospitalization and mortality among community-dwelling Canadians aged 65 or older

Death

% died within f/up

- Men
- Women
- 65-74
- 75+
- Gov't sources
- Other sources
- Smoker
- Non-smoker
- Underweight
- Normal/over
- Obese
- High SPH
- Low SPH
- Nut. Risk
- No nut. Risk

* p<0.05
After adjusting for demographic, health and socio-economic factors, seniors 65 years of age and older who reported being at nutritional risk were at increased risk for both hospitalization and death within follow-up.

1.2 Hazard ratio for hospitalization

1.6 Hazard ratio for death
How *have* linked CCHS to DAD been used?

**Using linked data to estimate excess days in acute-care hospitals for smokers**
by Kathryn Wilkins, Margot Shields and Michelle Rotermann

Available at: [https://www150.statcan.gc.ca/n1/pub/82-003-x/2009004/article/11033-eng.htm](https://www150.statcan.gc.ca/n1/pub/82-003-x/2009004/article/11033-eng.htm)
How did the likelihood of hospitalization in acute-care hospitals over the next 4 years differ by smoking status?

Percentage hospitalized in four-year period following interview, by age group and smoking status

Statistically higher than age-group estimate for “Never” (p<0.05)
Source: Linked 2000/01 Canadian Community Health Survey (CCHS) and Health Person Oriented Information (HPOI) (excludes Québec)
Estimated excess days for smokers and former smokers account for nearly one-third of all hospital days used by people aged 45-74.

Excess days for smokers, former smokers
= 7.1 million days
Considerations when using linked CCHS

Population out of scope:
- Persons living in institutions, on Indian reserves
- Quebec not available in DAD

Survey collection redesigns in 2007, 2015; changes over time to sample frame, target age, core content

Cross-sectional survey

Sample size of linked outcome

Respondent information available at baseline only
Linked Health Data available @ StatCan

Canadian Birth Census Cohort (CanBCC) (1996 and 2006)


Canadian Community Health Survey (CCHS) linked to the Longitudinal Immigration Database (IMDB):
CCHS – Annual cycles (2.1, 3.1, 4.1, 2008-2014) linked to IMDB ; CCHS – Focus content cycles (1.2, 5.2) linked to IMDB

Canadian Vital Statistics Death Database (CVSD) 2008-2014 linked to the Discharge Abstract Database (DAD) and the National Ambulatory Care Reporting System (NACRS) (2004/05 to 2014/15)

Longitudinal Immigration Database (IMDB) 1980-2013 linked to the Discharge Abstract Database (DAD) 2000/01-2013/2014
Where are the CanCHECs and linked CCHS data?

https://www.statcan.gc.ca/eng/rdc/data

https://crdcn.org/data
Who is using the CanCHECs and linked CCHS data?

### List of all RDC projects within the last 12 months

**Filter items**: Showing 1 to 10 of 406 entries | Show 10 entries

<table>
<thead>
<tr>
<th>Contract Title</th>
<th>Principal Investigator</th>
<th>Data Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 10-year retrospective study of predictors of fatal opioid overdoses in Canada</td>
<td>Anaee Bahjii</td>
<td>CCHS</td>
</tr>
<tr>
<td>A between-country dietary analysis and policy scan: Leveraging population-level dietary intake data to inform policy</td>
<td>Jennifer Vena</td>
<td>CCHS, Other-Non-StatCan</td>
</tr>
<tr>
<td>A comparison of datasets to study mobility in New Brunswick</td>
<td>Michael Hasn</td>
<td>GEN, IMDB, LAD</td>
</tr>
<tr>
<td>A decomposition of changes in Canadian wealth inequality</td>
<td>Brant Malcolm Abbott</td>
<td>SFS</td>
</tr>
<tr>
<td>A profile of immigrant health in Calgary using the Canadian Community Health Survey</td>
<td>Naomi Anna Lightman</td>
<td>CCHS</td>
</tr>
<tr>
<td>A re-examination of incentives and retirement</td>
<td>Kevin Scott Milligan</td>
<td>CIS, LAD, LFS, SLID, Other-Non-StatCan</td>
</tr>
<tr>
<td>A spatial-temporal analysis of migration patterns of Sudbury, Thunder Bay, Sault St. Marie, North Bay Ontario, and Timmins</td>
<td>Sean O'Hagan</td>
<td>CEN, NHS</td>
</tr>
<tr>
<td>A study of depression and suicidal ideation among the aboriginal Canadian population</td>
<td>Rasha Mohamed Shehata Amer</td>
<td>APS, CCHS</td>
</tr>
</tbody>
</table>

[https://www.statcan.gc.ca/eng/rdc/rdc](https://www.statcan.gc.ca/eng/rdc/rdc)
Contacts for questions regarding the U of C RDC can be directed to:

• RDC Analysts: Dina Lavorato, Stephanie Cantlay

• Email: rdc@ucalgary.ca

• Website: https://crdcn.org/prairie-regional-rdc
Thank you!

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