





MEETING START: 10:00 AM PACIFIC | 1:00 PM EASTERN

FOR AUDIO – PLEASE CALL:

1-855-494-5988

Phones will be muted until webinar start time









chat...





NOTE: A RECORD OF THE Q&A FROM THE CHAT WINDOW ARE AT THE END OF THE SLIDES





Why do we care about residential history?

Paul Villeneuve

Professor in the School of Mathematics & Statistics

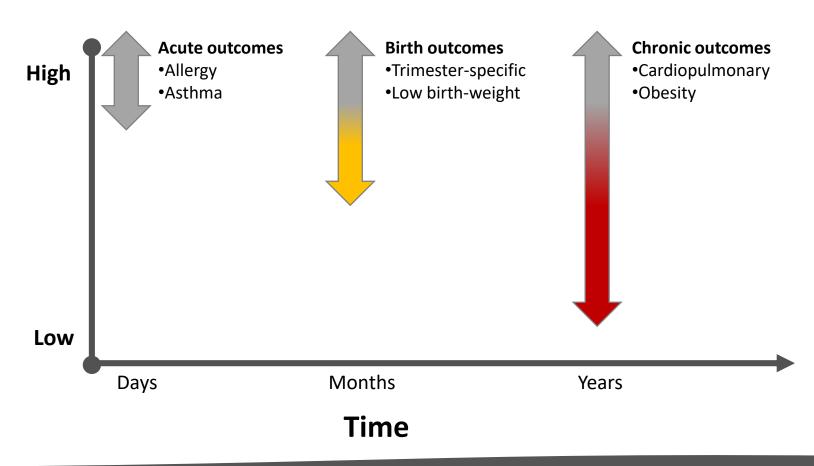
And Department of Neuroscience





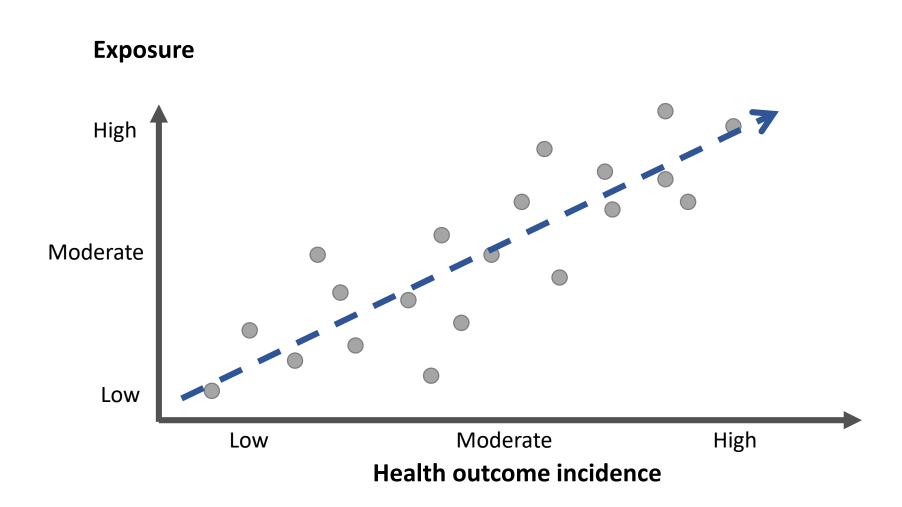


Accuracy of exposure using current postal code



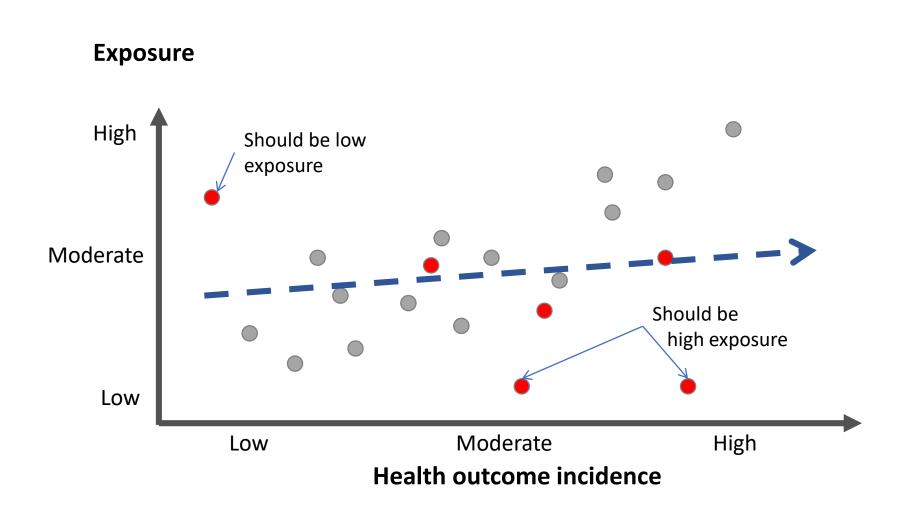
















Hystad et al, 2014. Greenness and birth outcomes

- Many studies of environmental exposure and pregnancy outcomes based on place of residence at birth
- Impact of environmental exposures on outcome vary by pregnancy trimester
- Used BC data, incorporated mobility during pregnancy – 37% moved during pregnancy
- Important source of exposure misclassification

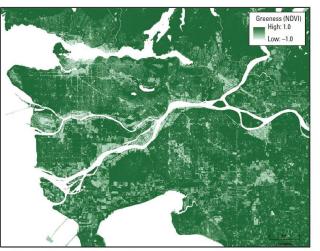
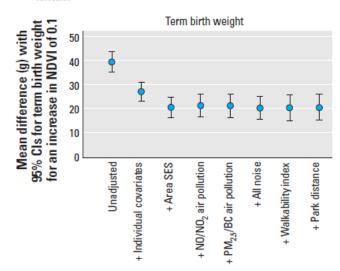


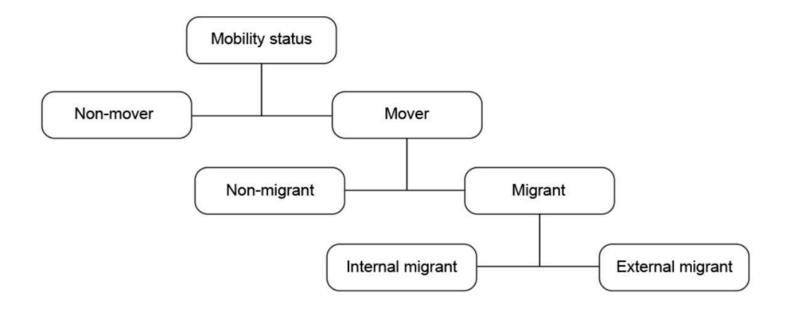
Figure 1. Spatial distribution of greenness for the study cohort measured with satellite-derived NDVI, Vancouver.







Census based measures of residential mobility







Residential mobility varies by several demographic factors

- Age
- Sex
- Marital status
- Children
- Educational attainment\Occupation

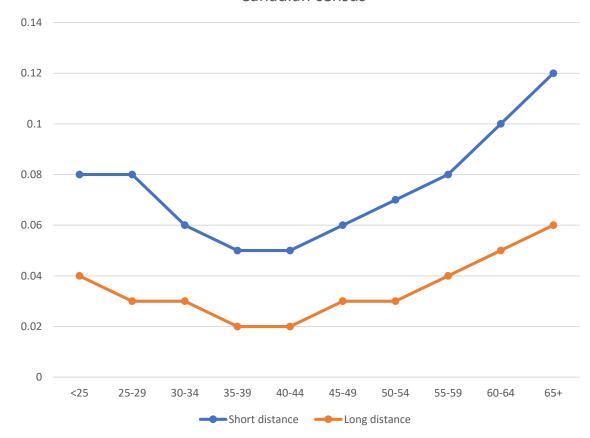
Nearly twice as many move short distance

Limitations

- Do not provide motivation for moving
- Do not provide information on residential history

Source: Pendakur & Young, 2013.

Proportion of household who moved in last 5 year, 2006 Canadian census



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Why do people move?





Polling data for top reasons for moving:

- Family size increase (marriage, kids etc.) 42%
- Job relocation 37 per cent, but much higher in Alberta 53%
- Family size decrease (divorce, death, empty nest etc.) 20%
- Retirement 18%
- Came into more money 14%
- Home was in need of renovations 14%

Census data from US identified top reasons as:

- A new or better home/apartment (15 percent)
- A family reason (other than getting married or starting a household) (15 percent)
- A housing reason (other than wanting a new or cheaper house, better neighborhood, etc.) (14 percent)
- To establish own household (10 percent)
- New job or job transfer (9 percent)





Epidemiological studies and possible bias from 'lacking' residential mobility

- Exposure measurement error, key considerations:
 - Error may be differential
 - Error will depend on spatial variability of exposure
- Self-selection bias (e.g., studies of greenness)
- Lacking exposure at critical time windows
- Limited ability to investigate 'natural experiments'





Statistics Canada Residential History Program

Michael Tjepkema

Principal Researcher, Statistics Canada, Division of Health Analysis





Statistics Canada's residential history program

Objective

Enhance health datasets by including environmental data from CANUE to facilitate environmental health research

How?

By using the Social Data Linkage Environment (SDLE) at Statistics Canada

- The SDLE is a highly secure environment that facilitates the creation of linked population data files for social analysis. It is not a large integrated data base.
- At the core of the SDLE is a Derived Record Depository (DRD), essentially a national dynamic relational data base containing only basic personal identifiers.
- The DRD is created by linking selected data (births, deaths, immigration and tax files for the purpose of producing a list of unique individuals.
- More information on the SDLE can be found here: https://www.statcan.gc.ca/eng/sdle/index

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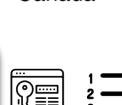


Residential History Construction: SDLE



Statistics Canada Statistique Canada





Subject IDs and linkage fields

SDLE

Residential history created and exposure assigned by postal code/year



Study participant IDs and yearly exposures



Historical exposure data by postal code/year

















Linkage results to DRD & postal code completion percentages

Canadian Partnership for Tomorrow Project (CPTP) regional cohorts







- More than 99% of respondents linked to DRD
- ~ 53% of respondents had complete postal code coverage for all eligible years
- More than 99% of respondents linked to DRD
- ~48% of respondents had complete postal code coverage for all eligible years
- ~97% of respondents linked to the DRD
- ~34% of respondents had complete postal code coverage



Statistics Canada

Statistique Canada

CHMS

- ~ 98% of respondents linked to DRD
- ~ 38% of respondents had complete postal code coverage for all eligible years

CCHS

~ 96% of respondents linked to DRD

CanCHEC

- 74% to 97% of respondents linked to the DRD depending on census year
- 67% to 74% of respondents aged 20 or older had complete postal code coverage depending on census year





A few words about SDLE postal codes:

Postal code sources

- 1. T1 Personal Master File (starting in 1981)
 - Every resident of Canada who earns taxable income is required to complete an income tax return after the end of year in which the income was received.
 - · Some late filer may not be included
 - Filer's mailing address may be updated later in the year if they communicated with the Canada Revenue Agency
- 2. Child Tax Benefit Identifier (starting in 2010)
- Other sources such as Vital Statistics databases and the Immigrant Landing file

How do tax postal codes compare to where someone lives?

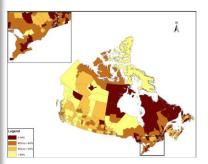
Study compared place of residence between T1 Family File and 2011 Census using record linkage

Results showed that postal codes were the same in tax data and in the census for 92.9% of the persons matched

Level of consistency of postal code varies by region with lower consistency in most parts of Western Canada

Consistency was less than 90% for young adults, persons aged 80 or older, recent immigrants, household income less than \$25,000, renters and those living in Band housing

Consistency of postal code (percent) by census division from census data



Bérard-Chagnon J. 2017 Comparison of Place of Residence between T1 Family File and the Census: Evaluation using record linkage. Demographic Documents, Statistics Canada. https://www150.statcan.gc.ca/n1/pub/91f0015m/91f0015m2017013-eng.htm

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Statistics Canada health databases with residential history

Canadian Health Measures Survey (CHMS)



- Between 5,600 to 6,400 respondents aged 3-79 per cycle
- Biennial survey: 5 cycles so far (2007-09, 2009-11, 2012-13, 2014-15, 2016-17)
- Data on self-reported health and risk factors, physical measurements (e.g. height, weight, blood and urine)

Canadian Census Health and Environment Cohort (CanCHEC)



- Between 2.6 million (1991) to 6.5 million (2011)
- Cohorts for each census year (1991 to 2016)
- Combines census data with administrative health data (e.g. mortality, cancer, hospitalizations, ambulatory care) and annual postal codes

Video: https://www.statcan.gc.ca/eng/sc/video/canchecs-new
Profile paper: https://www.statcan.gc.ca/eng/sc/video/canchecs-new
Profile paper: https://www150.statcan.gc.ca/n1/en/pub/82-003-x/2019012/article/00003-eng.pdf?st=VHYqLUCX

Canadian Community Health Survey (CCHS)



- Includes 15 annual component files and 5 focus content files starting from 2000/01 to 2017
- Survey data on self-reported health status, risk factors and health care use
- Combines CCHS data with administrative health data (e.g. mortality, cancer, hospitalizations, ambulatory care, Ontario mental health reporting system),annual postal codes and the T1 Family File (available summer 2020)

- Each dataset has annual postal codes attached to survey participants as early as 1981.
- These postal codes can be used to attach CANUE exposures (which are indexed by postal code) in the Research Data Centres

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





CANUE Data and Cohorts with Residential History

Dany Doiron

Research Associate, Respiratory Epidemiology and Clinical Research Unit, Research Institute of the McGill University Health Centre (RI-MUHC); CANUE data linkage experts





Health databases with residential history

Canadian Partnership for Tomorrow Project (CPTP) regional cohorts





- 29 850 participants aged 35 to 74
- Baseline data collection: 2009-2016
- Residential history: 1981 to 2016
- 99.9% linkage rate



- Province of Ontario
- 225 000 participants, age ≥ 18 years
- Baseline data collection: 2010-2017
- Residential history: 1981 to 2016
- 97% linkage rate



- 4 Atlantic provinces
- 35 935 participants age 18 to 78
- Baseline data collection: 2009-2015
- Residential history: 1981 to 2016
- 99.4% linkage rate









Exposure	Years covered
PM2.5	2000-2016
NO2 (annual and monthly)	1984-2012
SO2	2007-2015
O3 (annual and monthly)	2002-2015
NDVI Landsat (greenness)	1984-2016
MSDI (SES measure)	1989-2016 (index years + lead/lag time)
Can-Marg (SES measure)	1989-2008 (index years + lead/lag time)
Access to employment	2001-2016 (index year + lead/lag time)
Can-ALE (walkability)	2001-2016 (index years + lead/lag time)
Night light	1992-2013
Weather metrics	1983-2016
Water balance	1985-2015w
Local climate zones	1984-2016 (index years + lead/lag time)





Health databases with residential history

Canadian Partnership for Tomorrow Project (CPTP) regional cohorts





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- 35 935 participants age 18 to 78
- Baseline data collection: 2009-2015
- Residential history: 1981 to 2016
- 99.4% linkage rate

Sample file structure for PM_{2.5}

PersonID	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	13.4	13.2	12.8	11.8	11.5			11	10.5	9.9	9.8	9.6
2	15.3	15.3	15.3	15.3	12.8	12.8	12.8	12.8	12.8	11.3	11.3	8.3
3	10.1	13.2	12.8	11.8	11.5	11.3	11.2	8.4	9.8		9.4	8.8
4	7.7	7.7	7.7	7.7	6.4	6.4	6.4	6.4	6.4	5.8	13.2	12.8
5	9.8	9.6	9.4	8.8	8.3	7.9	7.7	7.3	6.2	5.8	5.8	5.8

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Making the Most of Residential History | February 4th | 2020







Fine Particulates

- A. van Donkelaar and R. Martin at Dalhousie University
- Satellite data
- 1 km resolution
- Annual average concentrations
- 2000 2016



MONTHLY ALSO

Nitrogen Dioxide

- P. Hystad for Health Canada
- Estimated at postal codes
- Annual average concentrations
- 1984 2012



Sulphur Dioxide

- Modelled by Environment Canada
- Satellite data
- 30km resolution
- Annual average concentrations
- 2007 2015



MONTHLY ALSO

Ozone

- Modelled by Environment Canada using CHRONOS and GEM-MACH
- 21- 10km resolution
- Monthly and annual average concentrations
- 2002 2015









Greenness

NORMALIZED DIFFERENCE VEGETATION INDEX

- Processed using Google Earth Engine
- 30m/250m/1km resolution
- Annual average, annual maximum and growing season average at each postal code, and within set distance buffers
- 1984 2015









Neighbourhood factors

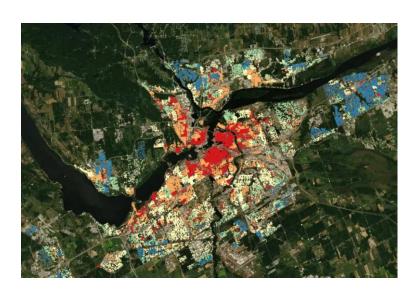
Material and Social Deprivation Index

- INSPQ using Pampalon method
- Based on census dissemination areas for 1991, 1996, 2001, 2006, 2011, 2016



Canadian Marginalization Index

- Flora Matheson
- Based on census dissemination areas for 1991, 1996, 2001, and 2006



Access to Employment

- 18 different variables using car vs transit access
- Based on census dissemination areas for 2016









Neighbourhood factors

Canadian Active Living Environments Index (Can-ALE)

- N. Ross at McGill University
- Based on census dissemination areas for 2006 and 2016



Nighttime light

- Satellite imagery
- 1 km resolution
- Annual average brightness
- 1992 to 2013









Weather and Climate

INTERPOLATED WEATHER STATION DATA

- Processed from station observations by NRCAN
- Estimated at postal codes
- Daily max/min temperature, total precipitation, consecutive days above/below threshold, extreme events
- 1985 2015

MODELLED WATER BALANCE METRICS

- Processed from station observations by NRCAN with model developed by CANUE weather team
- Estimated at postal codes
- Estimated % within 1km
- Census years 1986 2016

LOCAL CLIMATE ZONES

- Processed using Google Earth Engine/ LandSat and Local Climate Zone classification system
- Land uses that impact local climate
- Estimated % within 1km of postal code
- Census years 1986 2016











Residential histories with CanCHEC: practical applications

Dan L Crouse

Consulting Senior Scientist
Health Effects Institute, Boston

Using residential histories for time-varying exposure assignment





Journal of Exposure Science & **Environmental Epidemiology**

Original Article | Open Access | Published: 21 January 2015

Within- and between-city contrasts in nitrogen dioxide and mortality in 10 Canadian cities; a subset of the Canadian Census Health and Environment Cohort (CanCHEC)

Dan L Crouse ☑, Paul A Peters, Paul J Villeneuve, Marc-Olivier Proux, Hwashin H Shin, Mark S Goldberg, Markey Johnson, Amanda J Wheeler, Ryan W Allen, Dominic Odwa Atari, Michael Jerrett, Michael Brauer, Jeffrey R Brook, Sabit Cakmak & Richard T Burnett



Environmental Research Volume 159, November 2017, Pages 406-415



Associations between fine particulate matter and mortality in the 2001 Canadian Census Health and Environment Cohort

Lauren L. Pinault ^a $\stackrel{\triangle}{\sim}$ Scott Weichenthal ^{b, c}, Daniel L. Crouse ^d, Michael Brauer ^e, Anders Erickson ^e, Aaron van Donkelaar ^f, Randall V. Martin ^{f, g}, Perry Hystad ^h, Hong Chen ^{i, j}, Philippe Finès ^a, Jeffrey R. Brook ^k, Michael Tjepkema ^a, Richard T. Burnett

THE LANCET Planetary Health

Log in

ARTICLES | VOLUME 1, ISSUE 7, PE289-E297, OCTOBER 01, 2017

Urban greenness and mortality in Canada's largest cities: a national cohort study

Dr Dan L Crouse, PhD 🔌 🖾 • Lauren Pinault, PhD • Adele Balram, MPH • Perry Hystad, PhD •

Paul A Peters, PhD • Hong Chen, PhD • et al. Show all authors

Open Access • Published: October, 2017 • DOI: https://doi.org/10.1016/S2542-5196(17)30118-3

7-year moving window of NO₂

3-year moving window of PM₂₅

3-year moving window of greenness

Tracking annual residential mobility





Year	Postal Code
2011	K1A 0A2
2010	K1A 0A2
2009	K1A 0A2
2008	K1A 0A2
2007	H2T 1Y6
2006	H2T 1Y6
2005	H2T 1Y6
2004	H2T 1Y6
2003	H2T 1Y6
2002	H3B 1B7
2001	H3B 1B7

Tracking annual residential mobility





Year	Postal Code	City	Dissemination area (neighbourhood)	Local Exposure
2011	K1A 0A2	Ottawa	53022	4.2
2010	K1A 0A2	Ottawa	53022	4.4
2009	K1A 0A2	Ottawa	53022	4.8
2008	K1A 0A2	Ottawa	53022	5.0
2007	H2T 1Y6	Montreal	24601	11.0
2006	H2T 1Y6	Montreal	24601	11.2
2005	H2T 1Y6	Montreal	24601	11.2
2004	H2T 1Y6	Montreal	24601	11.6
2003	H2T 1Y6	Montreal	24601	12.0
2002	H3B 1B7	Montreal	24500	6.5
2001	H3B 1B7	Montreal	24500	7.0

5-year moving window of exposure, with a 1-year lag





Year	Postal Code	City	Dissemination area (neighbourhood)	Local Exposure	5-year moving average
2011	K1A 0A2	Ottawa	53022	4.2	7.3
2010	K1A 0A2	Ottawa	53022	4.4	
2009	K1A 0A2	Ottawa	53022	4.8	
2008	K1A 0A2	Ottawa	53022	5.0	
2007	H2T 1Y6	Montreal	24601	11.0	
2006	H2T 1Y6	Montreal	24601	11.2	
2005	H2T 1Y6	Montreal	24601	11.2	
2004	H2T 1Y6	Montreal	24601	11.6	
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2008	K1A 0A2	Ottawa	53022	5.0	11.4
2007	H2T 1Y6	Montreal	24601	11.0	10.5
2006	H2T 1Y6	Montreal	24601	11.2	9.7
2005	H2T 1Y6	Montreal	24601	11.2	8.8
2004	H2T 1Y6	Montreal	24601	11.6	8.1
2003	H2T 1Y6	Montreal	24601	12.0	7.3
2002	H3B 1B7	Montreal	24500	6.5	7.5
2001	H3B 1B7	Montreal	24500	7.0	7.7

3-year moving window of exposure, with a 1-year lag





Year	Postal Code	City	Dissemination area (neighbourhood)	Local Exposure	3-year moving average
2011	K1A 0A2	Ottawa	53022	4.2	7.0
2010	K1A 0A2	Ottawa	53022	-	8.1
2009	K1A 0A2	Ottawa	53022	4.8	9.8
2008	K1A 0A2	Ottawa	53022	5.0	11.5
2007	H2T 1Y6	Montreal	24601	-	10.5
2006	H2T 1Y6	Montreal	24601	11.2	11.4
2005	H2T 1Y6	Montreal	24601	11.2	-
2004	H2T 1Y6	Montreal	24601	11.6	-
2003	H2T 1Y6	Montreal	24601	-	J -
2002	H3B 1B7	Montreal	24500	-	-
2001	H3B 1B7	Montreal	24500	-	-

Comparing different time-windows





EPIDEMIOLOGY

Articles & Issues ♥ Collections Multimedia ♥ For Authors ♥ Journal Info ♥

ORIGINAL ARTICLE: PDF ONLY





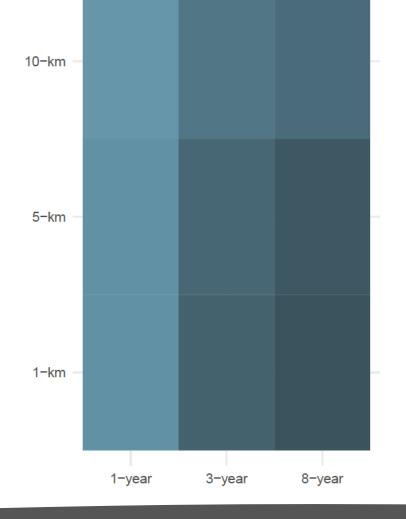
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Evaluating the Sensitivity of PM_{2.5}-Mortality Associations to the Spatial and Temporal Scale of **Exposure Assessment**

Crouse, Dan L1; Erickson, Anders C2; Christidis, Tanya3; Pinault, Lauren3; van Donkelaar, Aaron4; Li, Chi4; Meng, Jun⁴; Martin, Randall V.⁴; Tjepkema, Michael³; Hystad, Perry⁵; Burnett, Rick⁶; Pappin, Amanda³; Brauer, Michael²; Weichenthal, Scott*,7,8 **Author Information** ⊗

Epidemiology: November 4, 2019 - Volume Publish Ahead of Print - Issue doi: 10.1097/EDE.00000000000001136







BC Generations (BCGP) Residential History & Built Environment Project

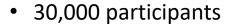
Dr Trevor Dummer

National Scientific Co-Director, Canadian Partnership for Tomorrow Project
Co-Scientific Director, BC Generations
School of Population and Public Health
University of British Columbia

BC Generations (BCGP)







- Baseline health and lifestyle data
- Linkage to admin health databases and cancer registry
- Physical measures and blood samples
- Follow-up health and lifestyle questionnaire
- Linkage to CANUE datasets:
 - baseline residential postal code
 - residential history postal code
- Data available via a data access application (research protocol, REB approval, access fee)





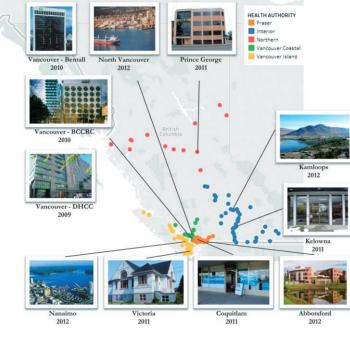


Cohort Profile: The British Columbia Generations Project (BCGP)

Anar Dhalla, 1 Treena E McDonald, 1 Richard P Gallagher, 1,2 John J Spinelli, 1,2 Angela R Brooks-Wilson, 3,4 Tim K Lee, 1,5 Calvin Lai, Marilyn J Borugian, 1,2 Ryan R Woods, 1 Nhu D Le, 1,6 and Trevor J B Dummer 1,2*

Table 1. BCGP data

Source	Measurements	Phase	Available numbers ^a
Health and lifestyle questionnaire	Self-reported sociodemographics, health status, life- style, screening tests, personal and family medical history, physical activities, self-report anthropo- metric measurements (height, weight, waist and hip circumferences), employment status, brief resi- dential history	Baseline (29 May 2009–31 August 2016)	28 825 (updated, harmonized)
Physical measurements	Clinically measured blood pressure, bone density, percentage body fat, height, weight, waist and hip circumferences, grip strength, lung function	2009–12	16 560 (Lung function: 4842)
Biosamples	Blood components, urine, with summarized preanalytical conditions	Baseline and 2013–14 campaign	Plasma: 26 454 Serum: 26 459 White blood cells: 26 453 Red blood cells: 26 453 Whole blood: 15 838 Urine: 26 377 Extracted DNA: 6276
Genotypes	Affymetrix UK Biobank Axiom 2.0 gene chip	2016-17	987 post-QC
Biomarkers	BioRad's Bio-Plex Pro TM Assay (cytokines, acute phase proteins, cancer biomarkers)	2017	2084 (data available later in 2018)
Residential history questionnaire	Location, housing type, heating fuel, water source of residences over lifetime	2015–16	22 095
Follow-up questionnaire	Similar to baseline health and lifestyle questionnaire New components: mental health, marijuana use and e-cigarette use	2016–17	22 688 (data available later in 2018)
Linkages			
BC Cancer Registry	Cancer diagnosis and mortality in BC	Ongoing	
Population Data BC	Health and vital statistics in BC	Ongoing	









Residential history & built environment project





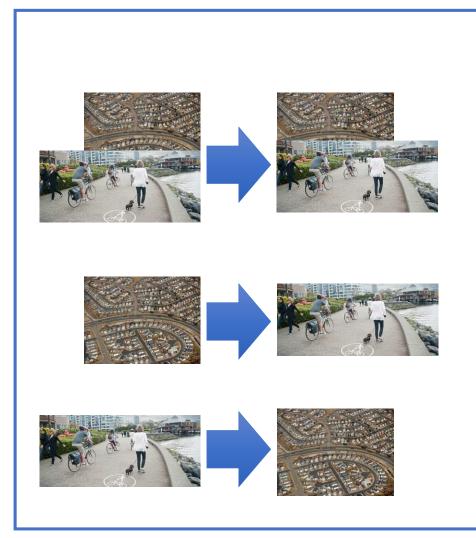
Three Objectives:

- Summarize the BCGP cohort in relation to green space, walkability, community SES and NO₂.
- Evaluate the association between green space, walkability, community SES (deprivation) and NO₂ and two important determinants of health -obesity and physical activity (PA)
- Summarize and describe residential mobility within BCGP 1985-2016

- Hypothesis: Walkability → Physical Activity → Improved Health?
- Issue: Selection bias in cross-sectional analysis? (i.e. the physically active self select the walkable communities)
- Solution: The residential history CANUE data supports longitudinal analysis. For example:
 - Through the lifecourse do people move to more or less walkable communities?
 - Does walkability change over time?
 - What is impact of built environment on PA, health, obesity over time?







Participants classified by neighbourhood walkability over time

a) "Maintainers" (includes movers and non-movers)

b) "Improvers"

c) "Decliners"

Change in walkability over time

- Classify people into groups based upon neighbourhood walkability in current and previous neighbourhood
- Categories include: Maintainers, improvers and decliners - Adapted from McCormack et al Int J Environ Res Public Health. 2017; 14(5): 551
- Evaluate characteristics of movers and move types related to built environment
- Evaluate impact of changing walkability on obesity, self reported health, etc.

Picture Sources

Suburbs - David Shankbone https://commons.wikimedia.org/w/index.php?curid=3781585
Walkable community - City of Vancouver, https://vancouver.ca/streets-transportation/walk-bike-and-transit.aspx





BC Generations (BCGP) -A regional cohort of the Canadian Partnership for Tomorrow Project (CPTP)

BCGP is:

Funded by CPAC, with additional support from the BC Cancer Foundation Hosted by BC Cancer

Funding for residential history project – CIHR/CANUE









THANK YOU!

Chat Q&A

Question for Mike. For CHMS...are those linked weighted to give representative data for Canada? Mike Tjepkema (10:26) - No new weights were created. The original CHMS weights could be used to represent the Cdn population at time of collection.

Sorry I missed it, how are the CPTP cohorts accessed?

Mike Tjepkema (10:27) - You would have to contact the CPTP cohorts directly as the analytical files are not available at StatCan.

Are any papers available about decision criteria made to determine residential histories if there were overlapping dates of stays at residences, or since you used tax history was this not an issue? Thanks!

Mike Tjepkema (10:40) - I am not aware of any papers but this really isn't an issue with SDLE postal codes.

Ok, thanks! I'm based in the U.S. and we're recreating RHs using a system which has many of these inaccuracies, unfortunately.

In the BCGP walkability study, how are you measuring historical walkability levels? -thanks

Trevor Dummer (10:56) Yes, CanALE data

(Eleanor Setton adds, post-webinar: Dr. Larry Frank (UBC) also has walkability data for 2006, 2011 and 206, which may be used for the study)