

# **Science for Public Health and Effective Environmental Law**

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For the Canadian Association for the Club of Rome, Ottawa

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# Background

## Coming up in Parliament

*The Right to a Healthy Environment*

is expected in the preamble of amendments to the  
***Canadian Environmental Protection Act***

Also on the agenda:

***Pest Control Products Act*** (Pesticides)

**What is needed to achieve the  
*Right to a Healthy Environment?***

**... Address toxic chemicals *and* climate  
imperatives**

# Advancing Health, Economy *and* Commerce

*If Canada is to increase trade with the E.U., as hoped for by Prime Minister Trudeau (speech in Rome, 2021), we'll need to advance **least-toxic** industries and agriculture.*

# Interacting Topics

## **Pollution: Costs, Disease, Environmental Degradation**

- Environmental contaminants and exposures (examples)
- History and adaptation (or not) of industries, commerce, governments and individuals

## **Laws, Regulation and Governmental Actions**

- Chemicals, Living Landscapes, Telecommunications

## **Reforms – Chemicals (CEPA), Pesticides (PCPA)**

- Measure, in order to manage
- Evidence for decision-making
- Precautionary Approaches, with Essentiality and Substitution

***The People Lead, so the Leaders will Follow***

# Environmental Contributors Human Health

## *Exposome*

All exposures

Beneficial and harmful

Over time

- In context of genetics, physiology, past health, even inheritance from previous generations

# Costs of Pollution in Canada

## International Institute for Sustainable Development

- Impacts on families, businesses and governments
- At least \$39 billion in 2015 (limited scope)
- Smog - \$36 billion in 2015

## ALSO

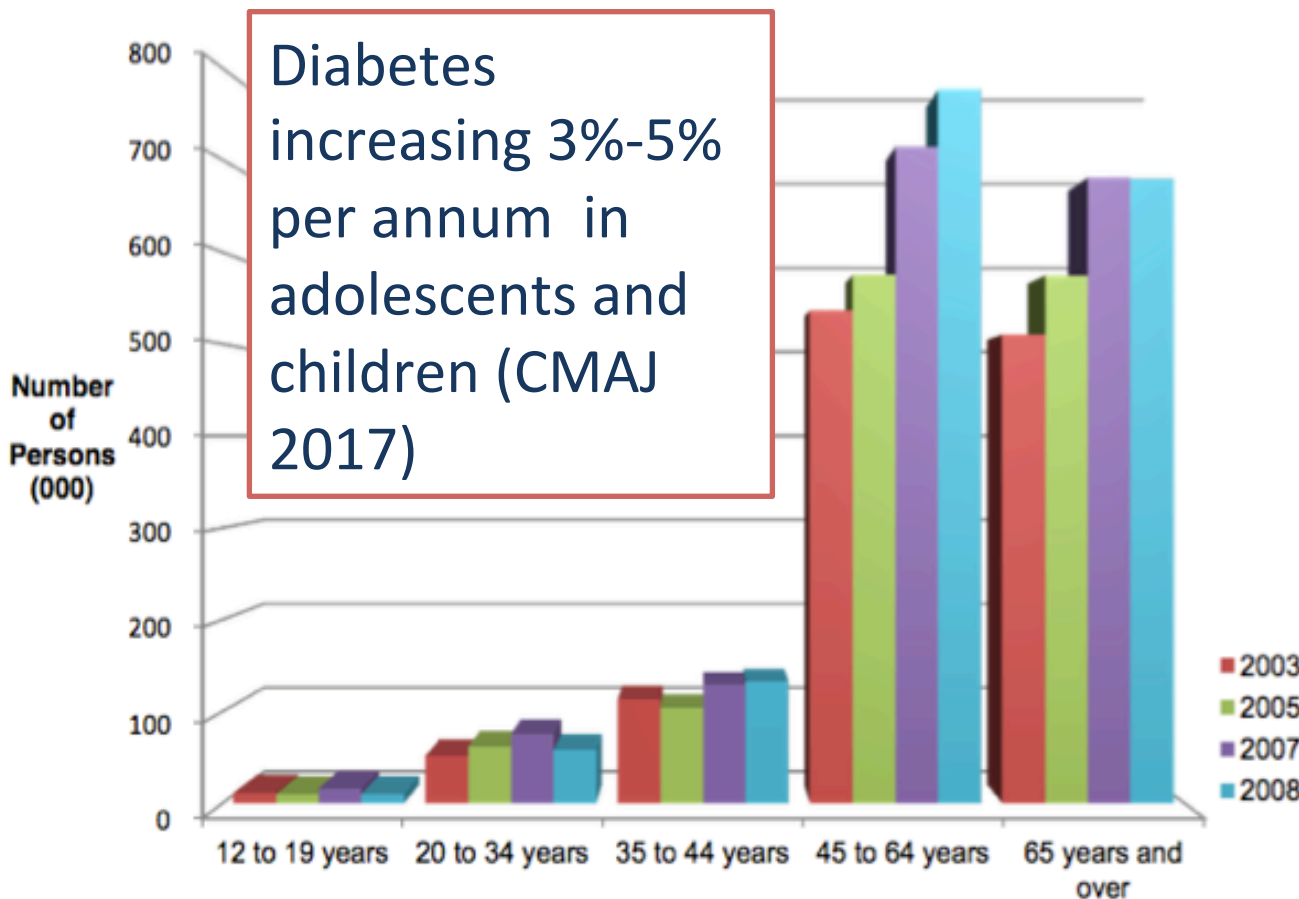
- (WHO) Persistent organic pollutants – obesity, diabetes, cancer, reproductive and developmental harms, autoimmune diseases
- Climate Change (CICC, Jn 2021) – deaths, deepening inequities, insecurities in housing, food, employment, health care ...
- Contaminated sites

<https://www.iisd.org/publications/costs-pollution-canada-measuring-impacts-families-businesses-and-governments>

<https://climatechoices.ca/reports/>

# Chronic Diseases increasing and Shifting to Younger Canadians (2003-2008, PHAC)

Cancer + cardiovascular disease + diabetes + hypertension  
Public Health Agency of Canada (2012)

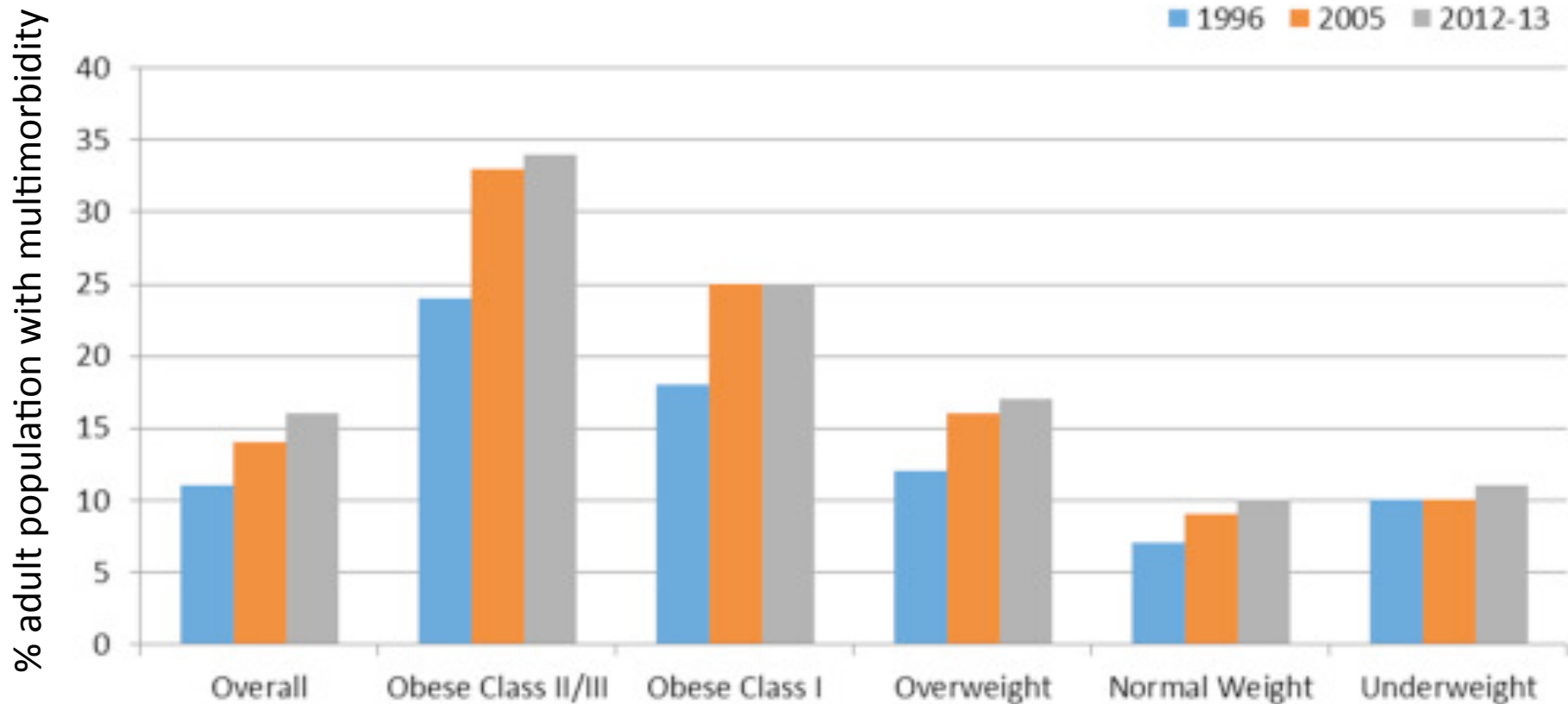


**More working age Canadians are living with diabetes**

**Increase of 1% per year in 35-44 year age group**

**Increase of 1.5% per year in 45-64 year age group**

# Multi-Morbidity According to Obesity



**Co-morbidities:** asthma, arthritis, high BP, diabetes, heart disease, cancer, stroke, COPD, and/or dementia

**Contributors:** 1. “obesogens” – chemicals that mimic or disrupt actions of hormones – the endocrine system – and cause weight gain; 2. microbiota in the gut



# Endocrine related hazards

Endocrine disrupting chemicals (EDCs) cause different effects at different doses

- High dose testing doesn't predict low dose effects, or vice versa
- Test at low and environmentally relevant doses
- New, rapid lab tests and computer models
- *Many* EDCs in common products

Example:

- Early life, low dose BPA on L
- Control mouse on R
- Estrogenic (linked to cancer)
- Early exposure affects gene expression
- Causes adult disease



**Many Similar Chemicals are in Canadians**

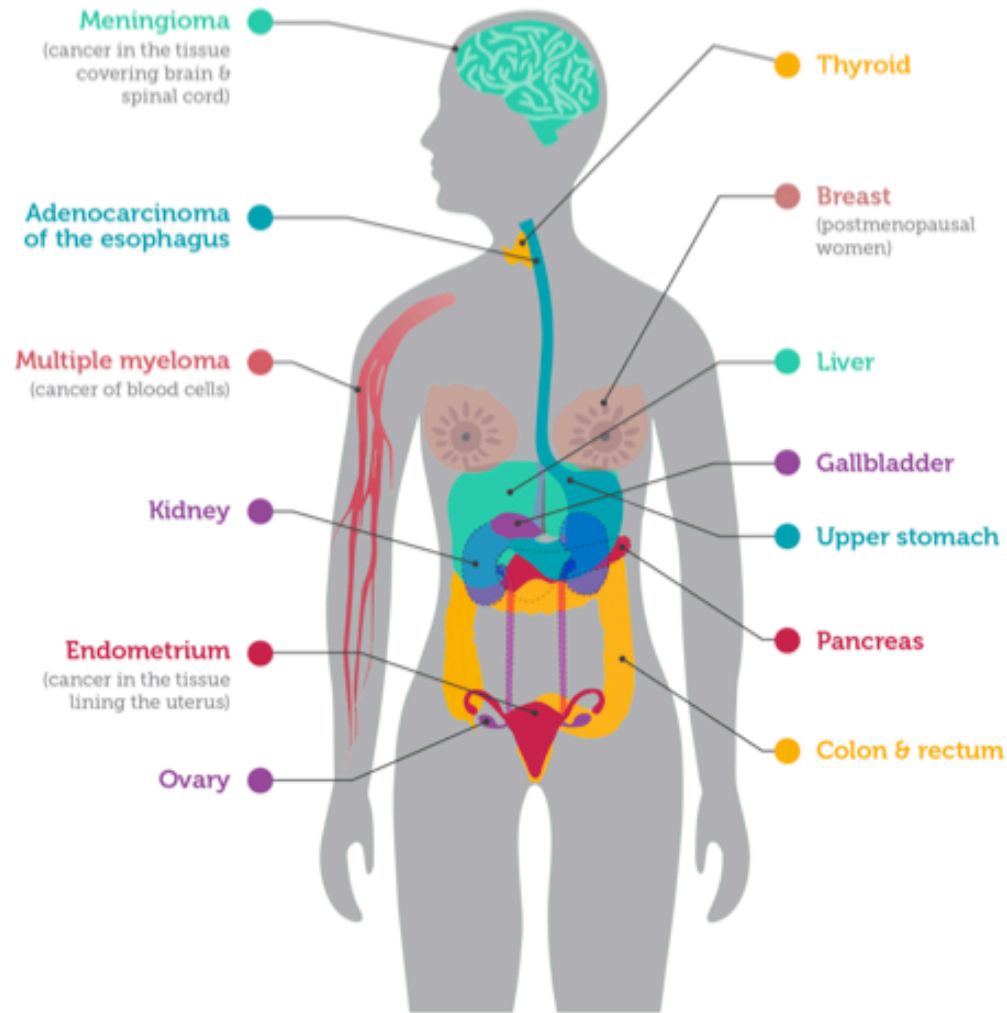
# Cancers associated with being overweight or obese

## WHY?

Inflammation and *Obesogens* contribute to cancers and other chronic diseases

[www.cancer.gov/about-cancer/causes-prevention/risk/obesity/overweight-cancers-infographic](http://www.cancer.gov/about-cancer/causes-prevention/risk/obesity/overweight-cancers-infographic)

[www.niehs.nih.gov/health/topics/conditions/obesity/obesogens/index.cfm](http://www.niehs.nih.gov/health/topics/conditions/obesity/obesogens/index.cfm)



# Getting to know cancer

## Halifax Project

- Contributors to cancer are common to many chronic diseases
- Need approaches for multiple *exposures*

Assessing the Carcinogenic Potential of Low-Dose Exposures to Chemical Mixtures in the Environment: The Challenge Ahead

[http://carcin.oxfordjournals.org/content/36/Suppl\\_1.toc](http://carcin.oxfordjournals.org/content/36/Suppl_1.toc)

A Broad-Spectrum Integrative Design for Cancer Prevention and Therapy

<http://www.sciencedirect.com/science/journal/1044579X/35//suppl/S>

### Hallmarks of Cancer



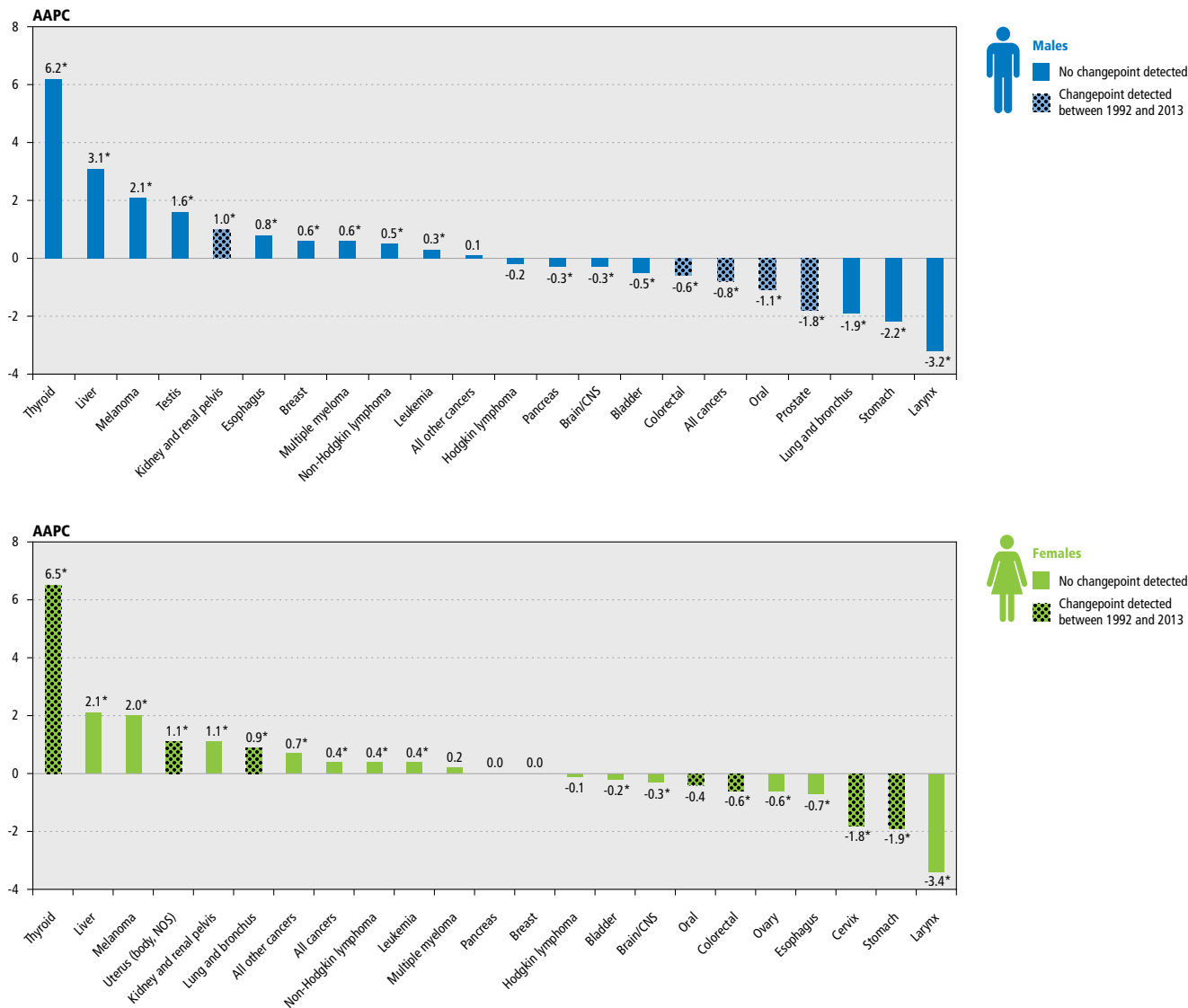
*Reprinted With Permission*

# Changing Rates of Cancer in Canada

Average annual percent change (AAPC)<sup>†</sup> in age-standardized incidence rates (ASIR), by sex, Canada, 1992–2013 (CCS 2017)

**Decreasing:**  
tobacco-associated  
cancers

**Increasing:**  
thyroid, liver,  
melanoma, testis,  
uterus, kidney/  
renal, eosophagus,  
breast,  
hematological,  
“all cancers”  
[EDCs play roles]



Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada

Data sources: Canadian Cancer Registry database at Statistics Canada

# Hypothyroidism in Newfoundland correlates with chemicals in fish

Mean hypothyroidism rates on three coasts in Newfoundland, Canada

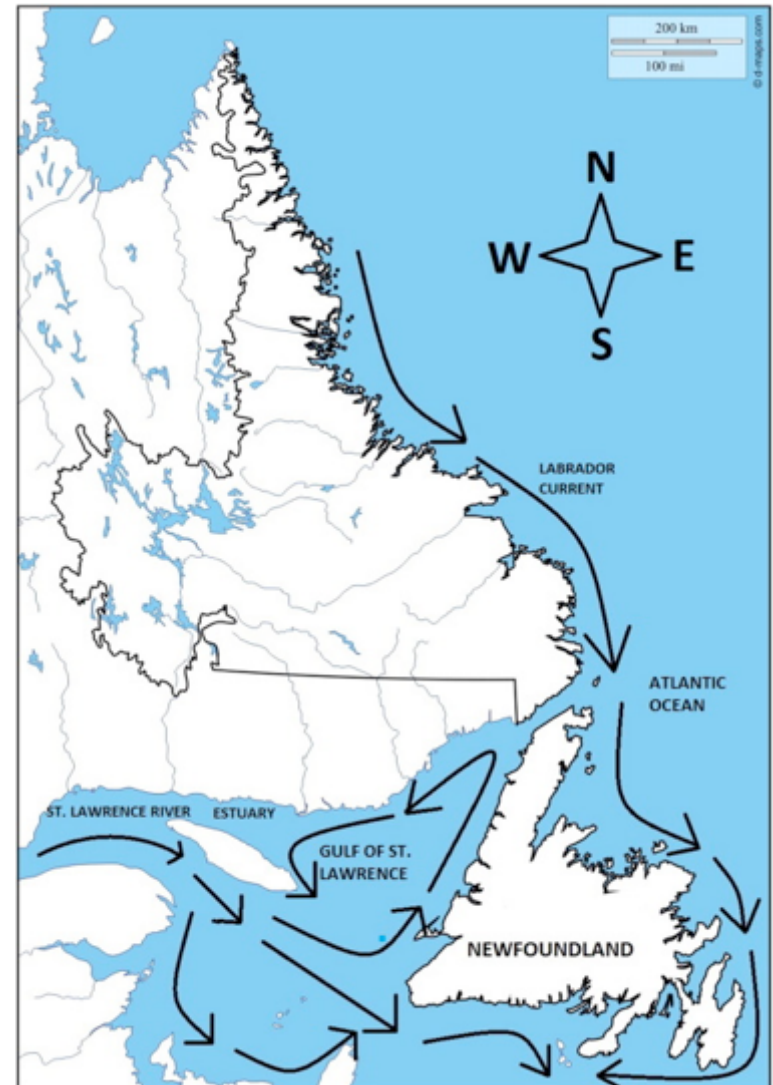
| Coast          | Hypothyroidism rate <sup>a</sup> | Average (SD) |
|----------------|----------------------------------|--------------|
| West           |                                  | 91.8 (36.73) |
| South          |                                  | 96.3 (51.96) |
| East           |                                  | 51.3 (20.25) |
| Comparison     |                                  | p-Value      |
| West vs. South |                                  | 0.974        |
| South vs. East |                                  | 0.057        |
| West vs. East  |                                  | 0.041        |

Calculated by averaging rates for communities within region.

<sup>a</sup>Number of people hospitalized with hypothyroidism diagnosis per 100,000 population per year.

Sarkar et al 2015. **Skewed distribution of hypothyroidism in the coastal communities of Newfoundland, Canada**

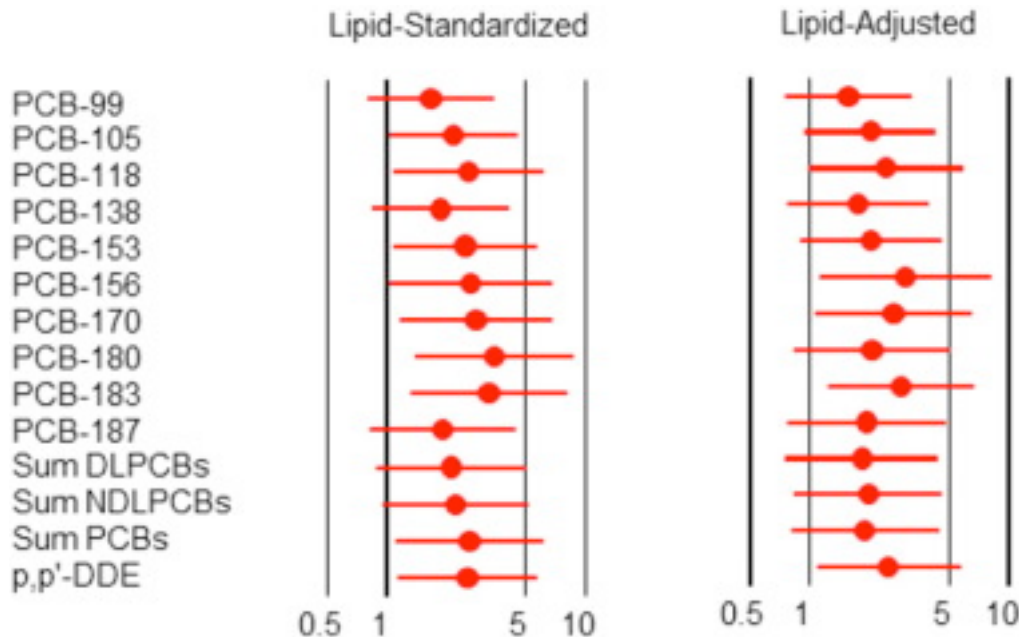
[www.sciencedirect.com/science/article/pii/S0160412015001531](http://www.sciencedirect.com/science/article/pii/S0160412015001531)



## Persistent organic pollutants and diabetes among Inuit in the Canadian Arctic

Kavita Singh, Hing Man Chan \*

Department of Biology, University of Ottawa, Ontario K1N 6N5, Canada



Blood PCB and p,p'-DDE levels were associated with increased risk of self-reported diabetes among Canadian Inuit.

Fasting glucose in the highest quartile of exposure was 3–7% higher compared with the lowest quartile of exposure.

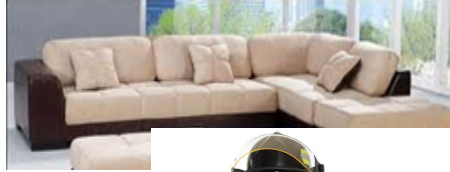
Adjusted odd ratios and 95% CIs (Q4 vs. Q1) for self-reported diabetes



# Persistent Organic Pollutants



Flame retardants  
in furniture,  
clothes, dust, gear



Permanent  
press - rash



Perfluorinated non-  
stick, and stain  
resistance chemicals



Food packaging



Electronics

# Environmental Contributors

## Pesticides

*PCPA to be on legislative agenda in 2022*

In foods / agriculture

- Canada increasing maximum residue limits

Indoors

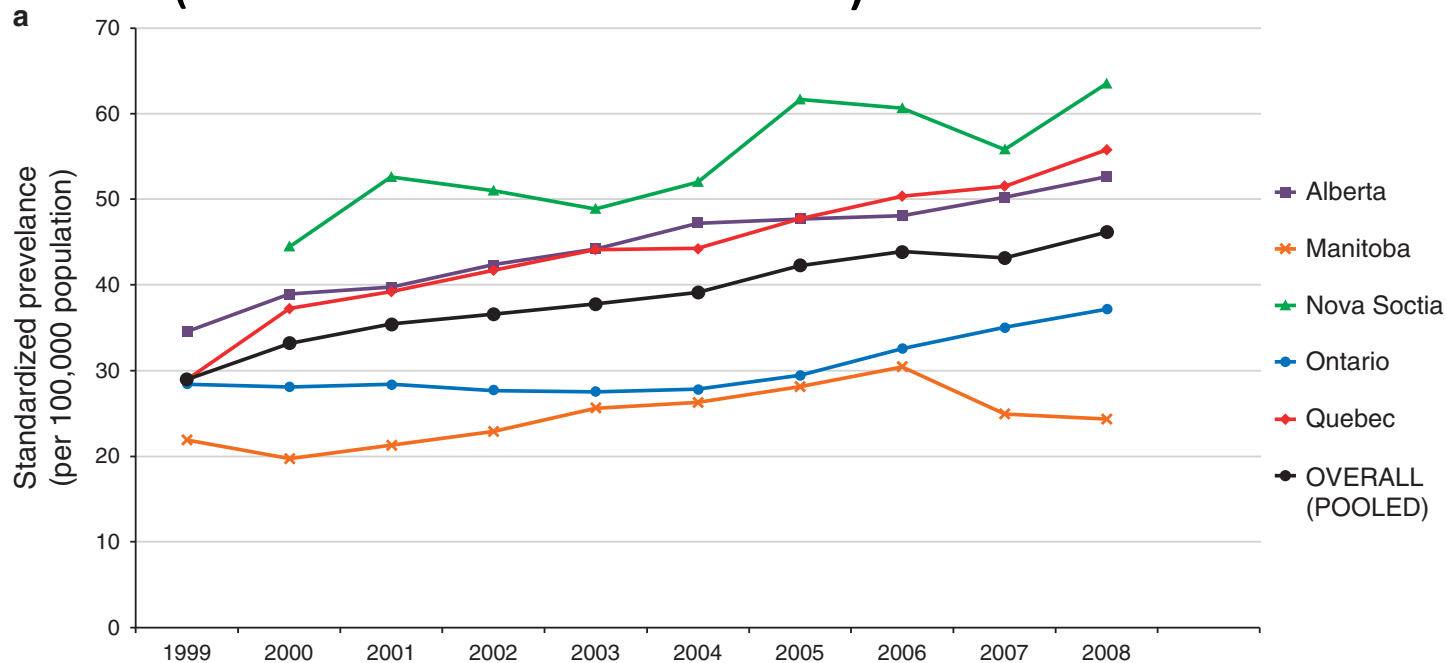
- Against insects, mould, microbes

Outdoors

- Landscaping, industrial, military



# Childhood onset inflammatory bowel disease (Benchimol et al. 2017)



Canada among highest prevalence of childhood IBD globally

**Increased 4.6% annually** from 1999-2010 in youth <16 y

Driven by **7% increasing incidence annually** in children <5y

Trends in Epidemiology of Pediatric Inflammatory Bowel Disease in Canada: Distributed Network Analysis of Multiple Population-Based Provincial Health Administrative Databases

<http://www.nature.com/ajg/journal/v112/n7/full/ajg201797a.html>

# Colorectal cancer

Increasing since 1996 in Canadian adults <50 y

6.7% per annum (15-29 y)

1.4% (30-39 y)

0.8% (40-49)

*Large increases in excess weight*

## ***DESPITE***

- Significant decreases in alcohol consumption and smoking
- Small increases in fruit and vegetable intake, and activity

*Patel et al. June 2017 Cancer Epidemiology*

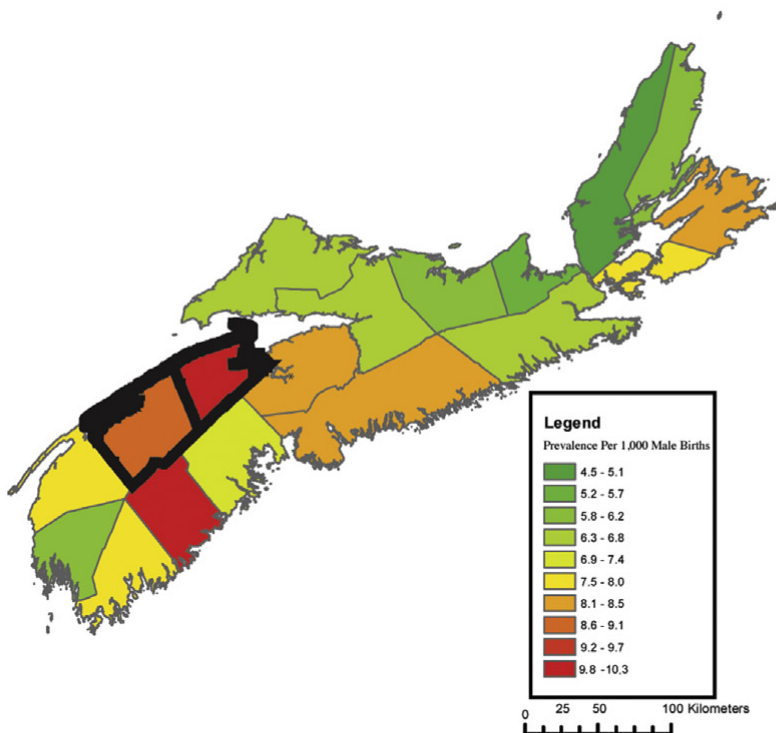
# Male birth defects

## Hypospadias and undescended testicles

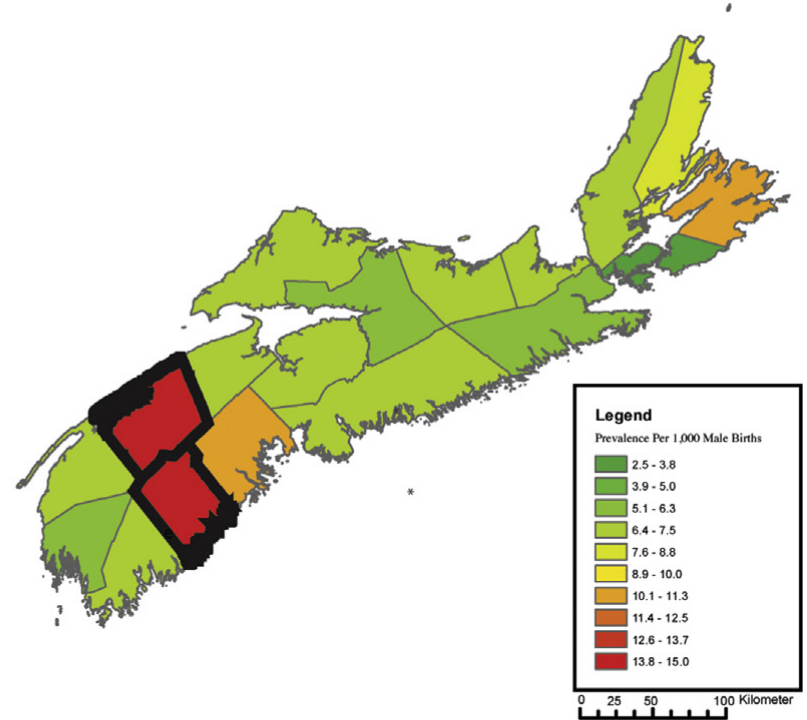
- Higher rates in Canada than US, internationally
- Geospatial clustering in NS high agriculture areas

(Lane et al. Journal of Pediatric Urology (2017) 13, 284.e1e284.e7)

Hypospadias



Cryptorchidism



# Multi-generational endocrine disruption

**Example:**

**Mothers' DDT level**



**Daughters' obesity and breast cancer**



**Granddaughters' early menarche and obesity  
(risking breast cancer and cardiometabolic disease)**

Grandmaternal Perinatal Serum DDT in Relation to Granddaughter Early Menarche and Adult Obesity: Three Generations in the Child Health and Development Studies Cohort

Cirrilo et al. 2021. Cancer Epidemiology and Prevention Biomarkers

# **Environmental Contributor**

## **Modern electromagnetic radiation (EMR)**

- The atmosphere blocks lower frequency EMR
- Telecommunications is increasing exposures
- “Microwave catalysis” is one mechanism explaining observed adverse effects including brain tumours in heavy cell phone users
- Radiofrequency radiation magnifies toxicities of chemicals

# Environmental Contributor

## Modern EMR-2

- Flora and fauna, particularly birds and insects, at increasing risk with increasing wireless deployment\*
- After large court case with 1000s of pages of scientific documents, US Federal Communications Commission ordered to review environmental effects
- Despite findings of 2015 Parliamentary Committee and subsequent Government Commitment, ECCC does no assessment, monitoring or research into environmental effects of radiofrequency radiation

**Include EMR assessment and regulation in CEPA**

\*Levitt et al. Effects of non-ionizing electromagnetic fields on flora and fauna.

1. Rising ambient EMF levels in the environment
2. Impacts: how species interact with natural and man-made EMF
3. Exposure standards, public policy, laws, and future directions

Reviews on Environmental Health, 2021

# Legal Reform

## “Managing” requires measuring

- Chemicals in Canadians - national surveillance inadequate – e.g., glyphosate
- ... in water, soil, air, food, indoor spaces, products we use – programs were scaled back and cut
- *Unknown* chemicals in modern products
- *Unknown* exposures to radiofrequency radiation from devices, antennae with directional outputs, satellites, “internet of things”

# Legal Reform

## Modern Science

Consider hormonally active / endocrine-disrupting chemicals (EDCs) in pesticides, plastics, household and personal products, cleaners, foods, toxic sites

➤ Highest exposed – workers, fence-line communities

*High dose research doesn't predict low dose effects, or vice versa*

➤ **Test at low, environmentally relevant doses**

➤ New, rapid lab tests and computer models

CHEMICALS



# Regulatory Reform for Precaution via modern science

- Modern science with v. small animals (e.g., fish embryos), cell cultures, biochemical and computer models are being validated
  - early prediction of adverse effects, and making safer, effective choices
- Chemical life cycle data
  - environmental and exposome estimates

# Plethora of pollutants

## Partial solution: Class Approach

Groups of chemicals with common mechanisms and toxic effects, but are regulated one at a time.

### *Never-ending regrettable substitutions*

1. PFAS - Anti-stick, anti-stain chemicals
2. Flame retardants
3. Antimicrobials
4. Phthalates and bisphenols
5. Some solvents
6. Certain metals

**See [SIXCLASSES.ORG](http://SIXCLASSES.ORG)**

# Legal Reform: Precaution via Essentiality and Substitution

**Precautionary Principle:** Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation. *Rio Declaration, 1992*

**Proving chemical harms can take generations**

Operationalized in the EU:

1. How *essential* is the use of the substance?
2. **RETHINK:** Can we do without, or *substitute* with innately less hazardous *process, product* or substance?

# Essentiality and Substitution

## Example

- Perfluorinated chemicals are toxic and persistent, cause cancer and birth defects
- Key ingredients in outdoors clothing, anti-stick and anti-stain products – e.g., Teflon
- Less toxic rubber-like and other substitutes are less hazardous, adequate for regular use
- PFAS might continue to be used in firefighters' water repellent *and* flame retardant gear

# Climate Lens

- From bitumen to product to shelf to disposal, “consumerism” drives carbon emissions.
- Some manufactured plastics “toxic” by merit of environmental footprint
- Apply “essentiality” for broader carbon reductions – e.g., fragrances
- Actions could range from prohibition to taxes

# Climate Lens - Agriculture

***Organic*** regenerative agriculture essential for carbon capture, and resilience

BC organic field  
with cover  
crops recovered  
well after floods



[www.no-tillfarmer.com/articles/11025-cover-crops-save-british-columbia-farmers-soil-from-massive-western-canada-floods](http://www.no-tillfarmer.com/articles/11025-cover-crops-save-british-columbia-farmers-soil-from-massive-western-canada-floods)

# Legal Reform

## Precaution for vulnerable populations

Mandatory margins of safety for people who are more vulnerable because of:

- Age and stage of life (*including prenatal*)
- Innate biochemistry to metabolize and excrete toxicants
- Stresses, Socio-economic status
- Access to nutritious food
- Housing
- *Occupation*
- Co-exposures and history of exposures

**Additional factor was introduced in PCPA, 2002  
... but was discounted in assessments**

# How much evidence is sufficient for action?

If action awaits proof of harm, how much harm is done while:

1. Links are researched, then recognized?
2. Actions are finally taken?

*Generations of people are exposed and harmed before a human carcinogen is recognized; longer before it is acted upon.*

## ETHICS

- PRECAUTION and PREVENTION require a shift to permitting only *least-toxic approaches / best practices*
- Individuals might make some personal choices ... with knowledge, availability and resources



# Measure to Manage Environmental Health Information Infrastructure

## 1. Fill “exposure” data gaps:

Environmental and biomarker data  
(Including cohort studies, and federal “open data”)

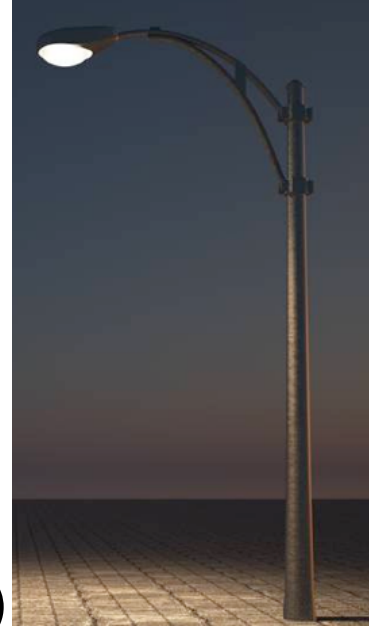
Clinical tools and research on personal exposures

## 2. **Electronic Infrastructure** to house environmental exposure data (using consensus meta-data), that can be linked with health data

Environmental exposures (beneficial and adverse; many data sources)

Personal exposure data – e.g. surveys, aggregated data

***Pan-Canadian Health Data Strategy***



# Ambition, for Health *and* Commerce

- The European Union aims to reduce synthetic pesticides use by 50% by 2030.
- Canada paused the planned increased pesticides in many foods, according to CODEX agenda (cooperating with industry group, CropLife).

*If Canada is to increase trade with the E.U., as hoped for by Prime Minister Trudeau (speech in Rome, fall 2021), we'll need **least-toxic** industries and agriculture.*

# Over to you!

**How should Canada's two major laws for environmental and human health protection be amended?**

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**See [preventcancernow.ca/take-action-now/](http://preventcancernow.ca/take-action-now/)**