

Using population cohorts to support COVID-19 research

Philip Awadalla,

National Scientific Director, CanPath

Executive Scientific Director, Ontario Health Study

Professor, University of Toronto

Director, Canadian Data Integration Centre



CanPath

Canadian Partnership
for Tomorrow's Health

Partenariat canadien
pour la santé de demain



Understanding disease risk factors is challenging

1 in 2

Canadians will die from cancer or a chronic disease*



- 1 in 2 Canadians will be diagnosed with **cancer**
- 1 in 12 Canadians live with diagnosed **heart disease**
- 1 in 10 Canadians live with **asthma or COPD**

Large-scale population health cohorts help assess disease risks



As cohorts collect data on participants over time,

- some **develop diseases**,
- **some die** and
- some **remain disease free**.

Population laboratories are “invaluable for understanding gene-environment interactions in complex human disease.”*



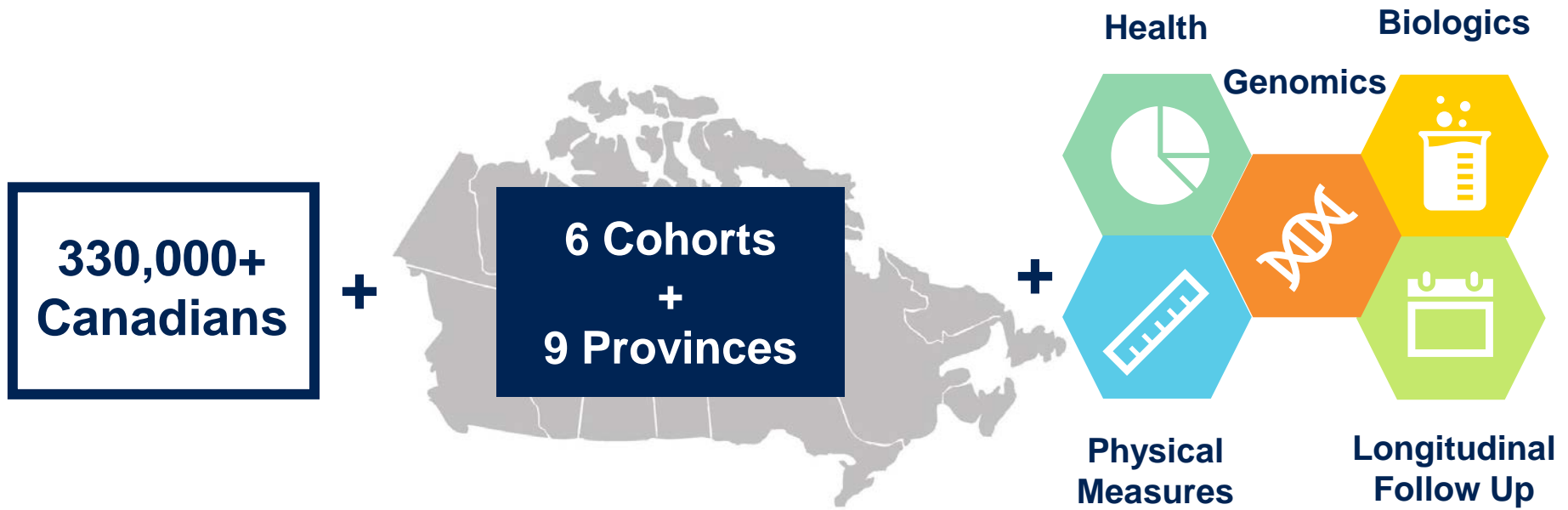
*Genes, environment and the value of prospective cohort studies, Manolio TA, 2006

Canada's largest population health research platform

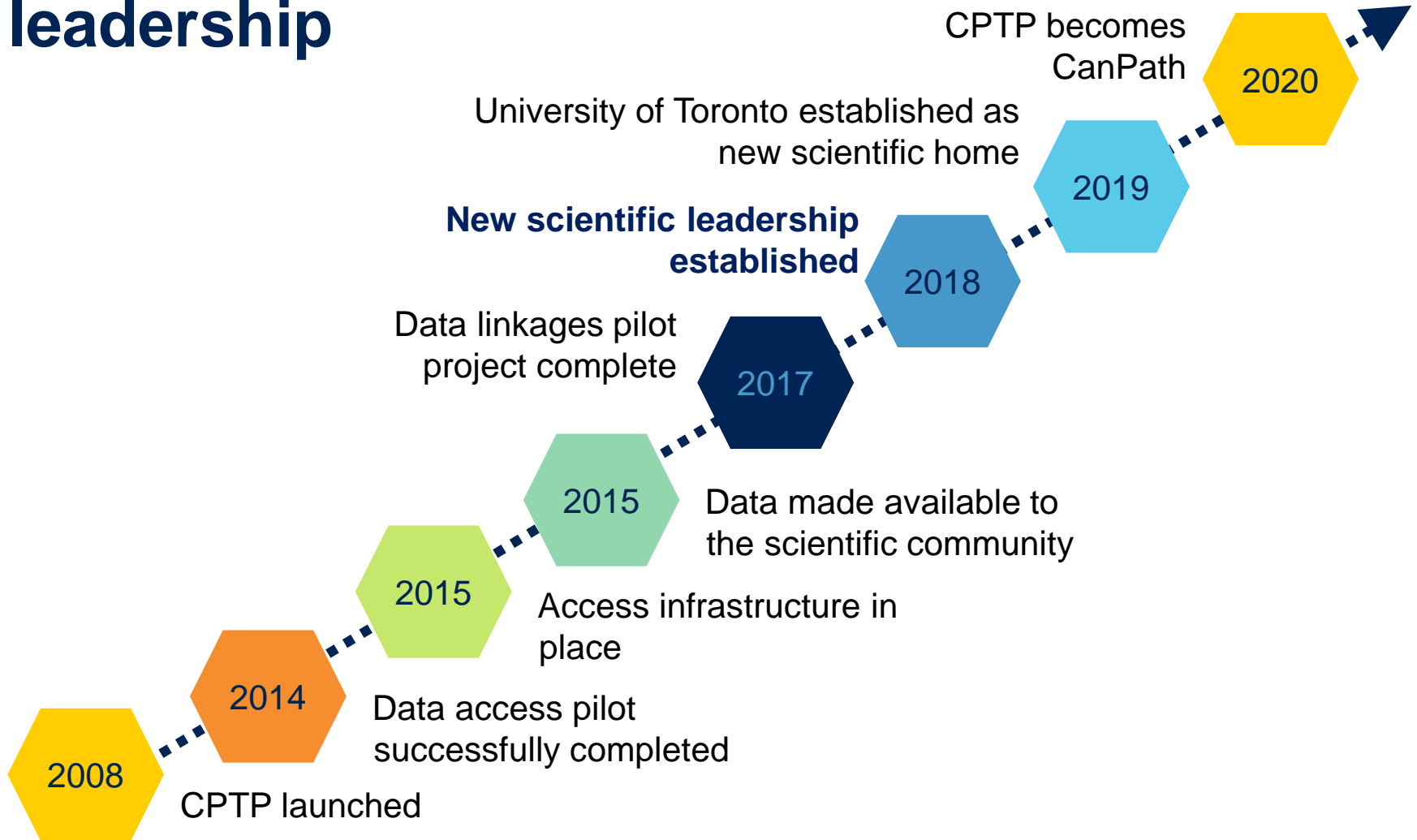


CanPath is a **population-health research platform** for assessing the effect of genetics, behaviour, family health history and environment on chronic diseases.

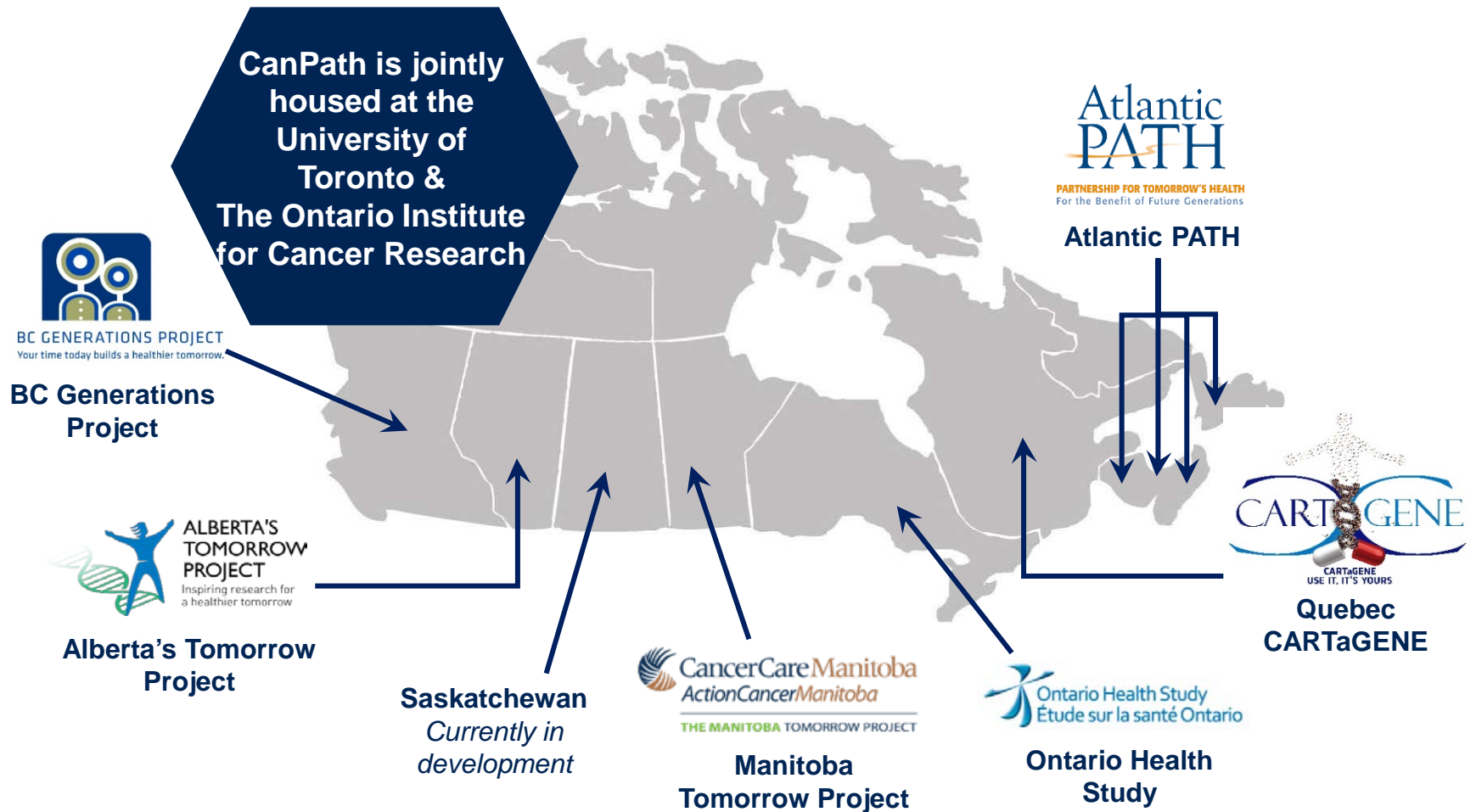
Canada's largest population health research platform



CanPath has entered a new era of scientific leadership



CanPath brings together six cohorts across nine provinces



National Leadership Team



Philip Awadalla
National Scientific Director;
Ontario Health Study



John McLaughlin
Executive Director



Trevor Dummer
National Scientific Co-Director;
BC Generations Project



Parveen Bhatti
BC Generations Project



Shandra Harman
Alberta's Tomorrow Project



Jennifer Vena
Alberta's Tomorrow Project



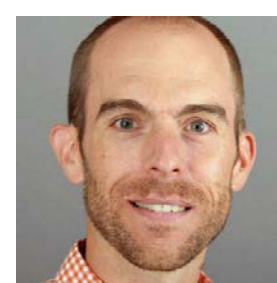
Donna Turner
The Manitoba Tomorrow Project



Philippe Broët
CARTaGENE



Simon Gravel
CARTaGENE



Guillaume Lettre
CARTaGENE



Jason Hicks
Atlantic PATH

330,000 Canadians are followed longitudinally

1
in every
100
Canadians
participate



BC GENERATIONS PROJECT
Your time today builds a healthier tomorrow.

**BC Generations
Project**

29,800



**Alberta's Tomorrow
Project**

41,374



**Manitoba Tomorrow
Project**

Recruiting



**Ontario Health
Study**

213,003



Atlantic PATH

36,003

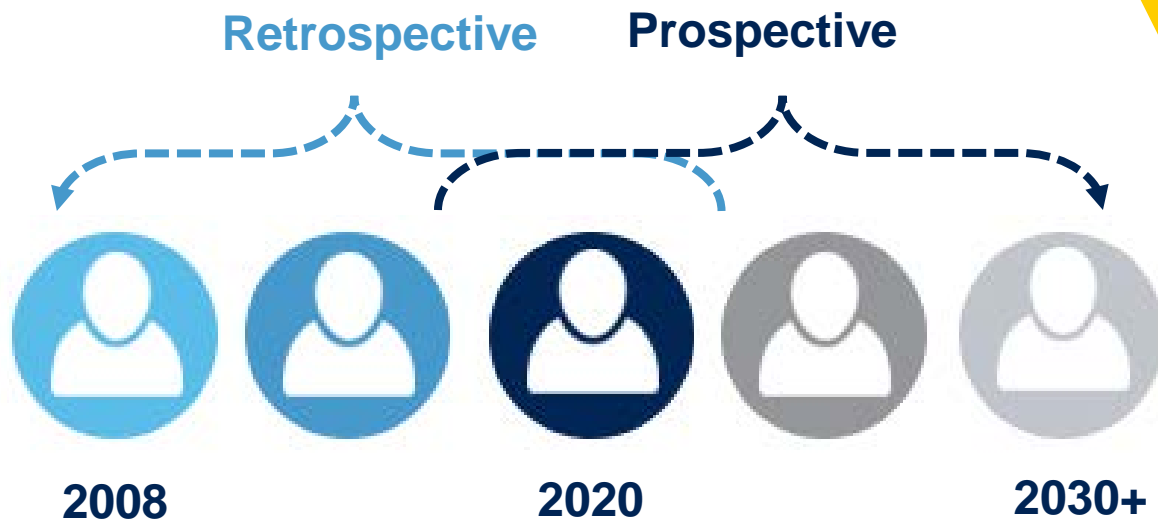


**Quebec
CARTaGENE**

43,609

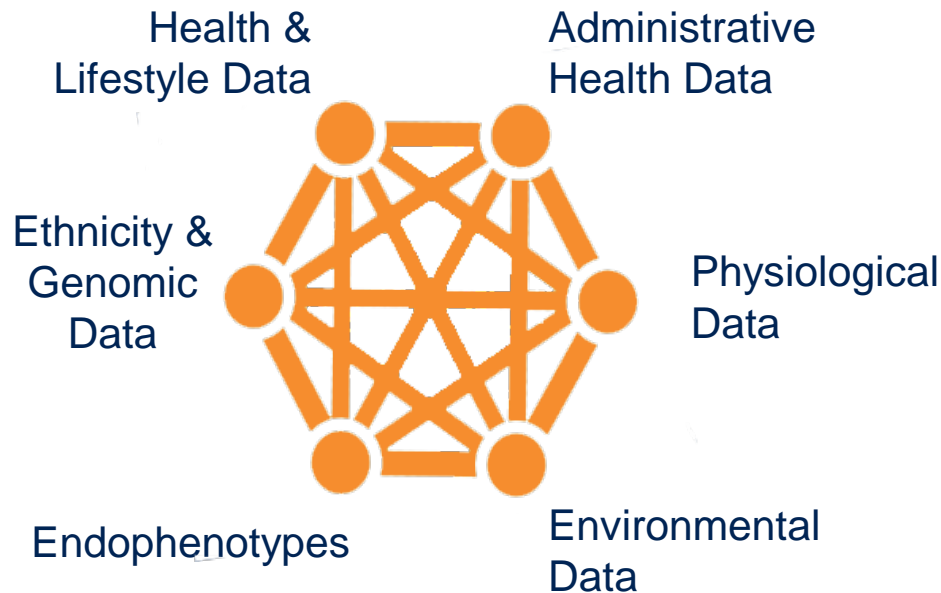
CanPath enables both retrospective and prospective research

Over 190 projects supported



- CanPath participants are followed for over 50 years (a decade in already!)
- Longitudinal cohorts enable scientists to perform health-related research for **today and for those in years to come**

CanPath captures a broad range of data to enable the study of health and disease



CanPath is **linking personal, behavioural, environmental, health system and biological data** to investigate cancer and chronic disease causes and determinants.

Health and and lifestyle data in CanPath



Blood

General hematology
Basophils
Eosinophils
Lymphocytes
Monocytes
Neutrophils
White cells
Hb
Hematocrit
MCHC
MCV
Packed cell volume
Platelets
Red cells
RBCDW
HbA1C



Serum

Lipid profile
Cholesterol
HDL-cholesterol
Triglycerides
HDL-ratio
LDL-cholesterol
Glycemia
Glucose
Hepatic function
Electrolytes
Kidney function
Creatinine
Nutritional status
Thyroid function
Uric acid
Thyroxine
TSH



Macro Measures

Arterial stiffness
Cardiac function
Blood pressure
Lung function
Grip strength
Weight
Height
BMI
Waist-hip circumference
Bioimpedance
Depression
Anxiety
Diseases / conditions
Imaging and MRI data



Environmental Measures

Diet questionnaire
Smoking status
Geographical location
Sun exposure
Exercise / sedentarity
Residential history
Income
Education level
Rural / urban
Siblings
Medications
Alcohol consumption
Sleep

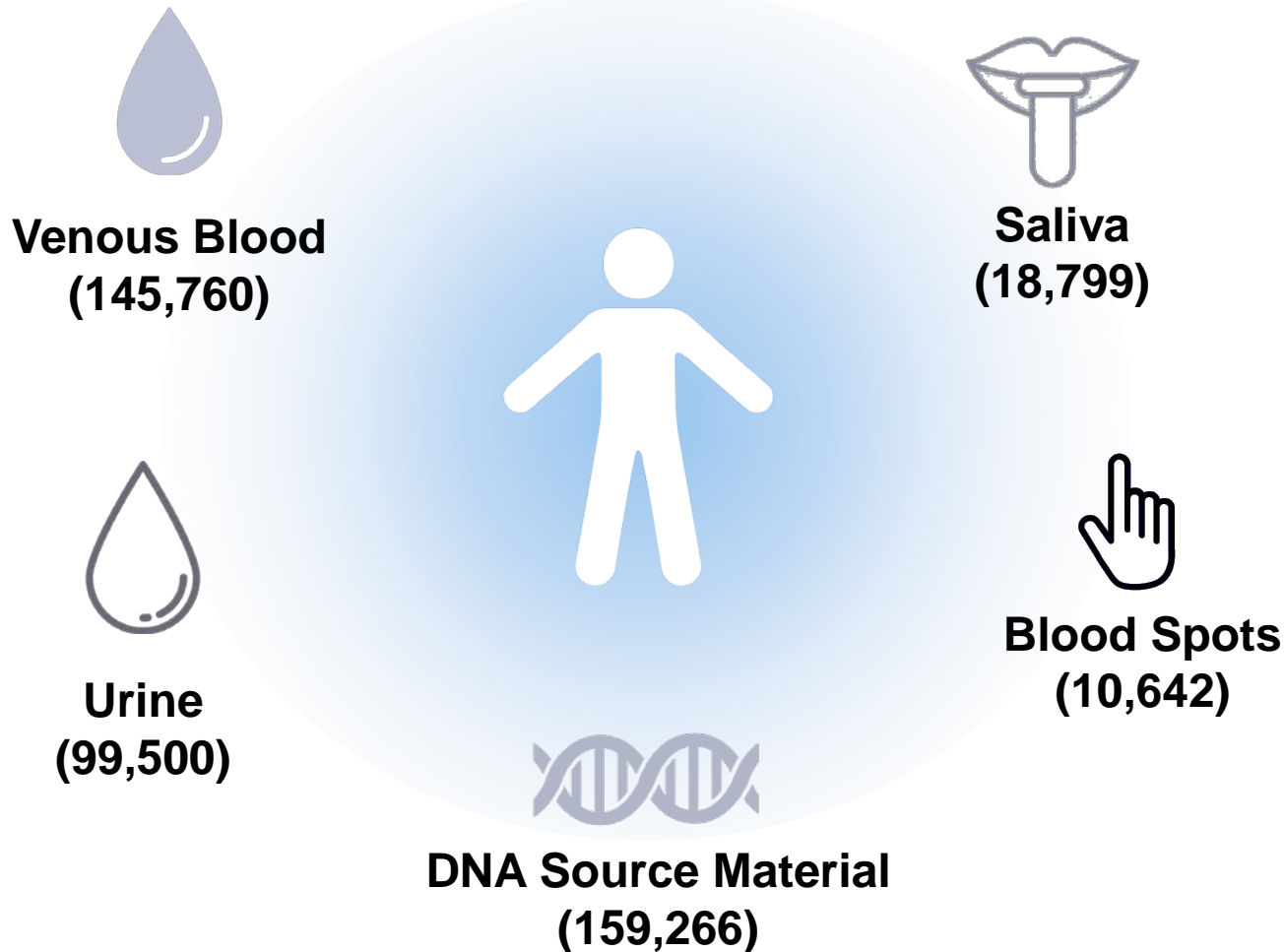
Comprehensive physical measures data



Physical measures

Cognitive test	Reaction time, memory, executive function
Anthropometric measures	Height, sitting height, waist and hip circumference, weight
Bioimpedance	BMI, impedance, % body fat, fat mass, fat free Mass, total body water, basal metabolic rate
Grip strength	Right and/or left hands
Bone density	Heel of non-dominant leg: Stiffness index, % young adult, T score, % age matched, Z-score, BUA and SOS values
Lung function	Timed peak and forced inspiratory and expiratory flow, vital capacity: FVC, FEV1, FEV1/FVC, FEF25, FEF50, FEF75, FEF25-75, FET, FEV3, FEV3/FVC, FEV6, PEF, EVol, FIVC, FIV1, PIF, ELA. MVV.
Blood pressure	Systolic and diastolic blood pressure, heart rate
Arterial stiffness	Heart rate, Aortic Systolic and diastolic pressures, Aortic augmentation, Aortic augmentation index, Ejection duration, and Buckberg ratio
Partial resting electrocardiogram	Leads: I,II, III, aVR, aVL et aVF. Heart rate, PQ Interval, QRS duration, QT, QTC, P-R-T axis, P duration, RR and PP Intervals.
MRI (n=10,000 participants)	Full body, n=10,000 participants, Combination of hospital centres and mobile units.

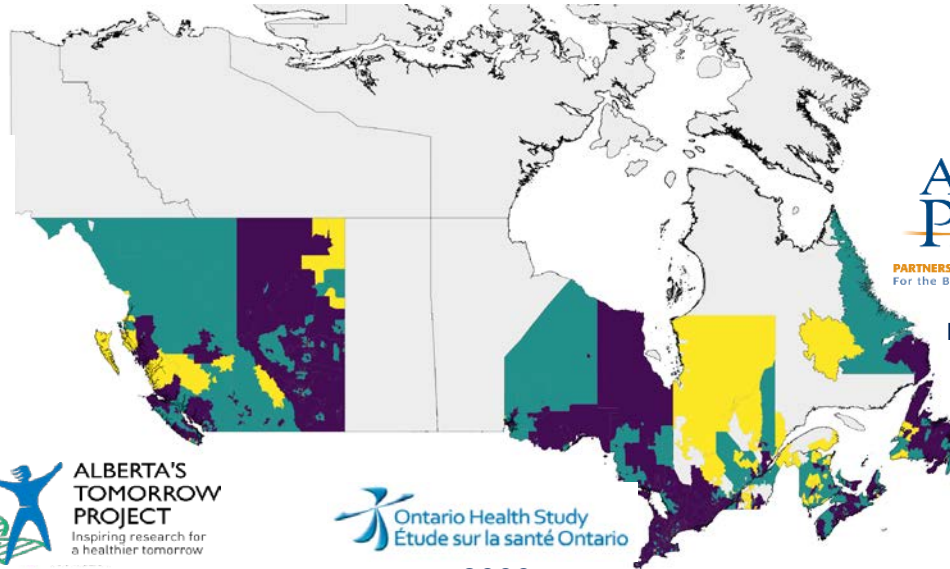
Longitudinal sampling of biological data



Genotyping data

Total of ~ 12,000 genotyped participants including ~488 T2D with high quality genotyping

Genotyped participants per FSA



1-11

12-132

133-1520



BC GENERATIONS PROJECT
Your time today builds a healthier tomorrow.

n= 1000

Atlantic
PATH

PARTNERSHIP FOR TOMORROW'S HEALTH
For the Benefit of Future Generations

n= 1000



n= 1000



n= 8000



n= 13000

Affymetrix UKBB
Illumina GSA

Genotype
Imputation

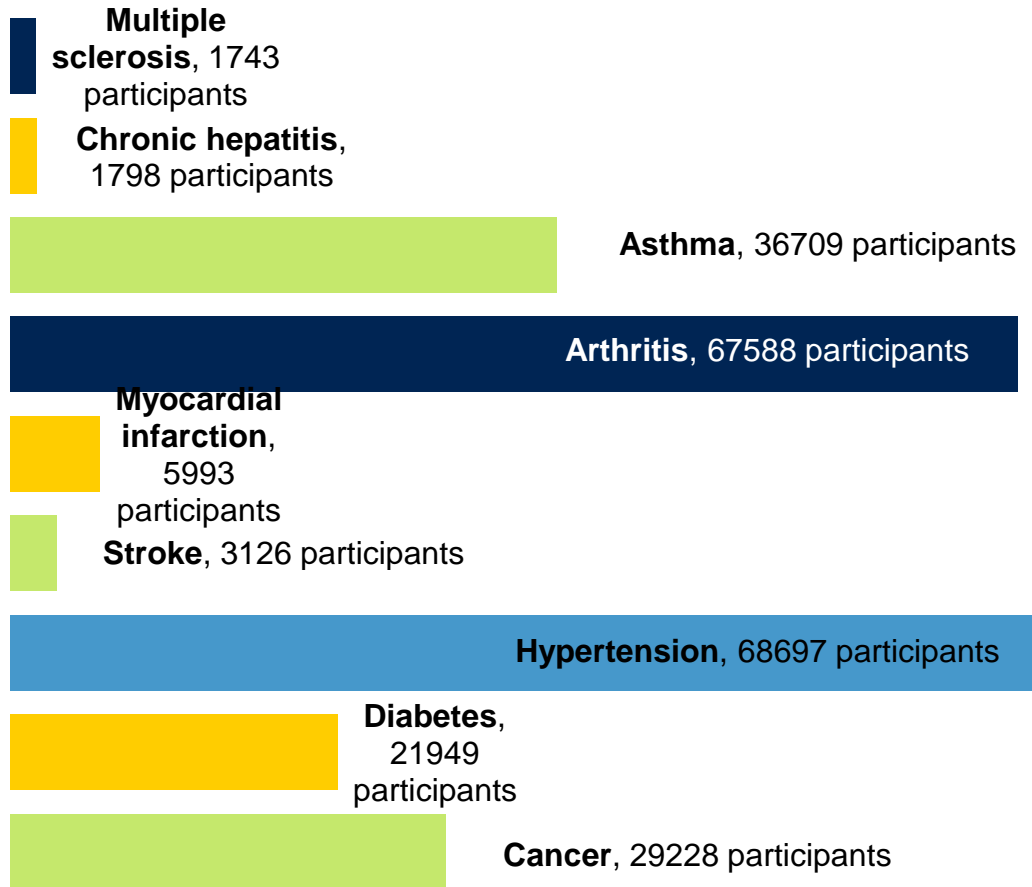
Reference	Observation	Prediction
A A A G	A/G	A G
A T A A	A/A	A A
T T G T	./.	T T
G G G G	./.	G G
A G A A	A/A	A A
T T T T	T/T	T T
C G G C	C/G	C G

Overall perception of health status in CanPath

The majority of CanPath participants **report good health** at the time of questionnaire completion



Common diseases and conditions reported in cohort












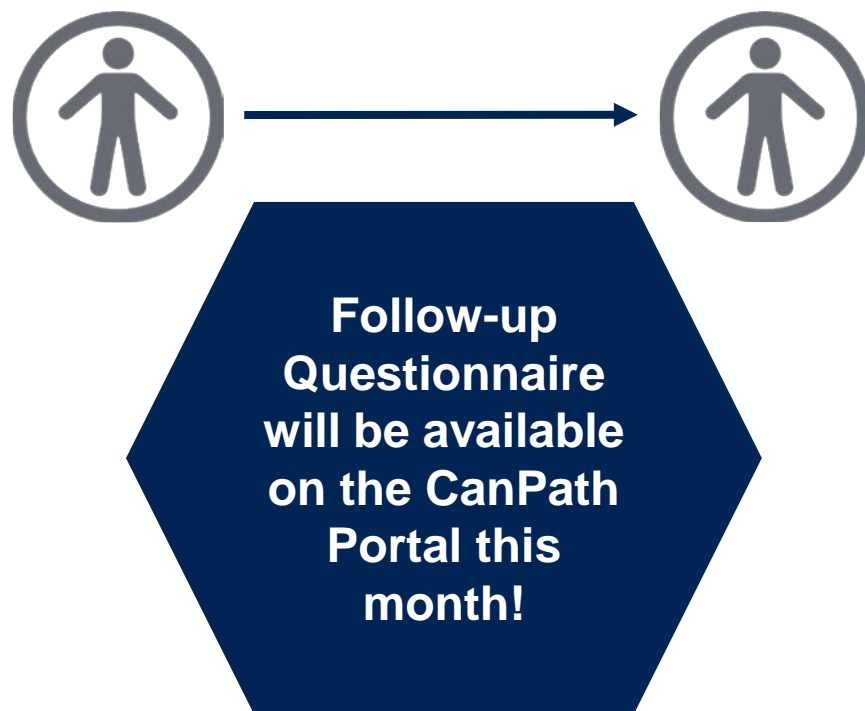
Including participants with various chronic diseases and conditions (at baseline)

The Canadian Partnership for Tomorrow Project: a pan-Canadian platform for research on chronic disease prevention

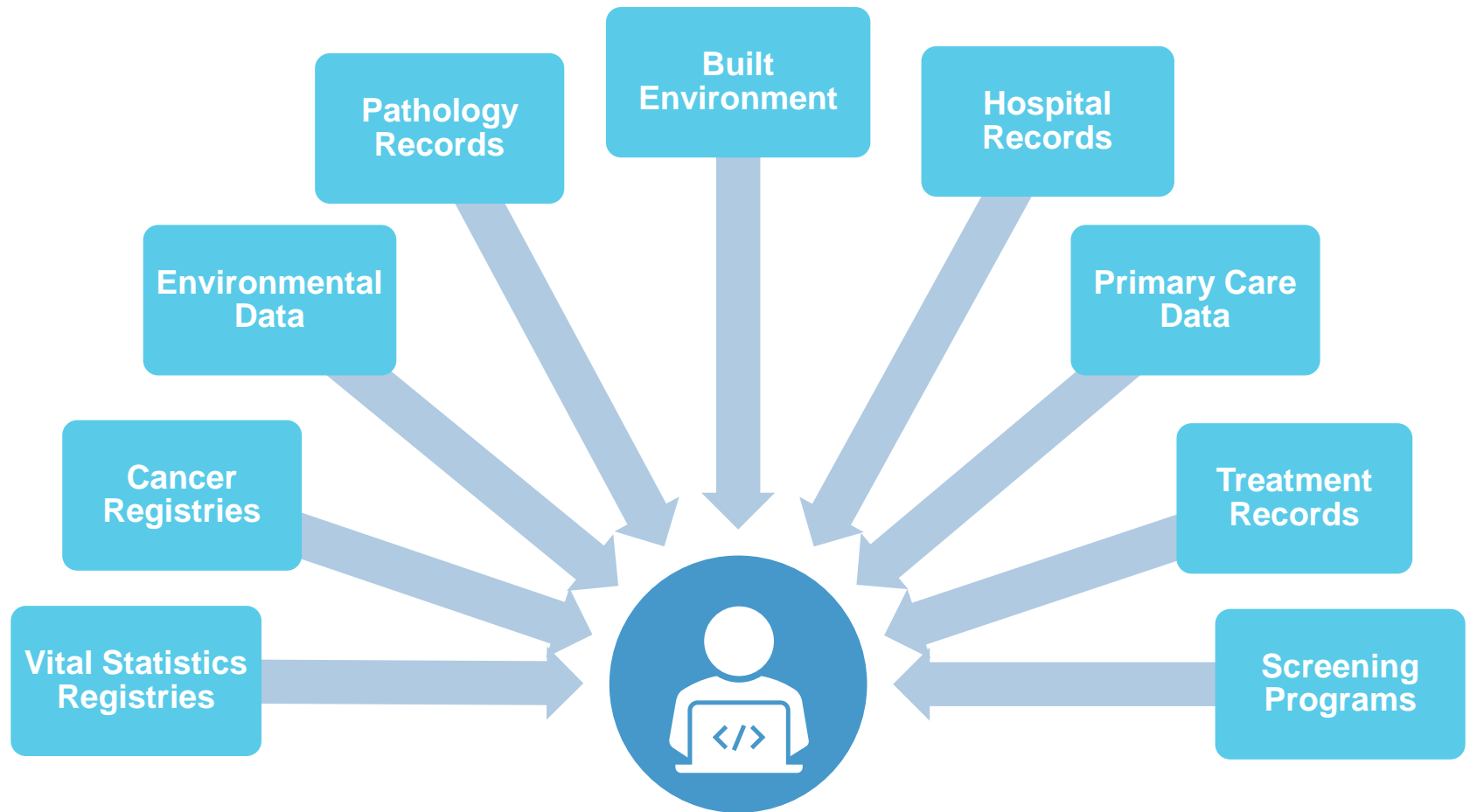
Trevor J.B. Dummer PhD, Philip Awadalla PhD, Catherine Boileau PhD, Camille Craig MSc, Isabel Fortier PhD, Vivek Goel MD, Jason M.T. Hicks MSc, Sébastien Jacquemont MD, Bartha Maria Knoppers PhD, Nhu Le PhD, Treena McDonald MSc, John McLaughlin PhD, Anne-Marie Mes-Masson PhD, Anne-Monique Nuyt MD, Lyle J. Palmer PhD, Louise Parker PhD, Mark Purdue PhD, Paula J. Robson PhD, John J. Spinelli PhD, David Thompson MSc, Jennifer Vena PhD, Ma'n Zawati LL.M.; with the CPTP Regional Cohort Consortium*

Over 120,000 CanPath Participants have completed detailed follow up questionnaires

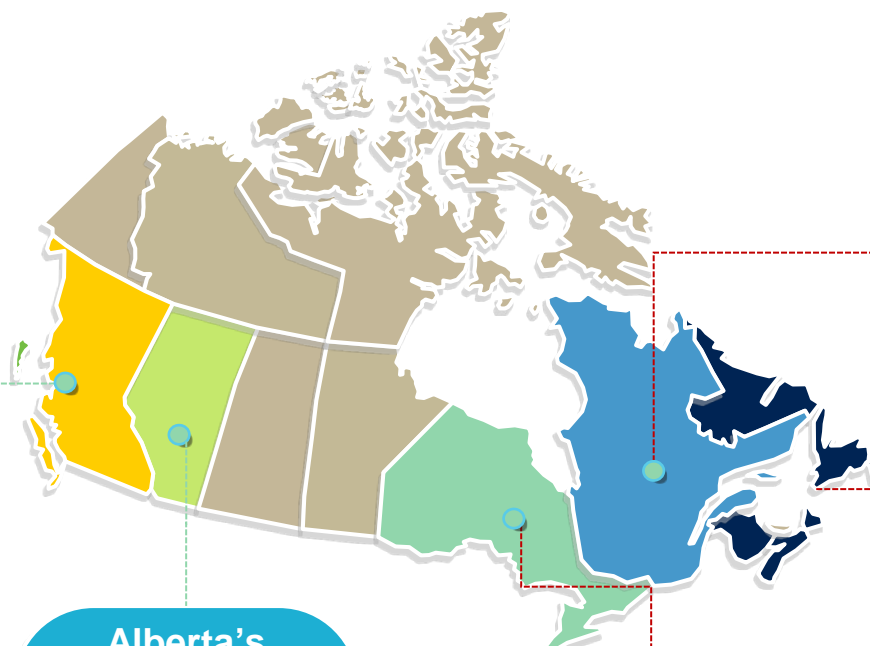
-  Participant demographics
-  Health status
-  Medical history
-  Prescribed medication
-  Family health history
-  Anthropometric measurements
-  Working status
-  Household income
-  Behaviours (sleep, alcohol, tobacco, marijuana use, and e-cigarette use)



Data linkages enable us to evaluate our cohort in real-time



Administrative health linkages can be completed within regional cohorts



BC Generations Project

- BC Ministry of Health
- BC Vital Statistics Agency
- BC Cancer

Alberta's Tomorrow Project

- Alberta Health Services
- Alberta Health
- Alberta Cancer Registry

Ontario Health Study

- ICES
- Cancer Care Ontario

CARTaGENE

- Institut de la statistique du Québec (ISQ)
- Tumor Registries

Atlantic PATH

- Newfoundland & Labrador Cancer Registry

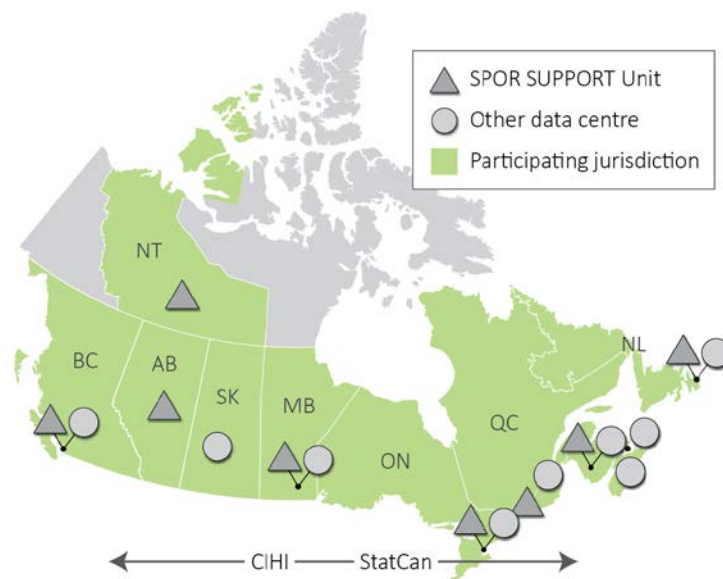
Multi-Region Data Linkage through HDRN

CanPath and **Health Data Research Network Canada (HDRN Canada)** are partnering to facilitate multi-jurisdictional linkage between CanPath cohorts and regional data holders through the Data Access Support Hub (DASH)

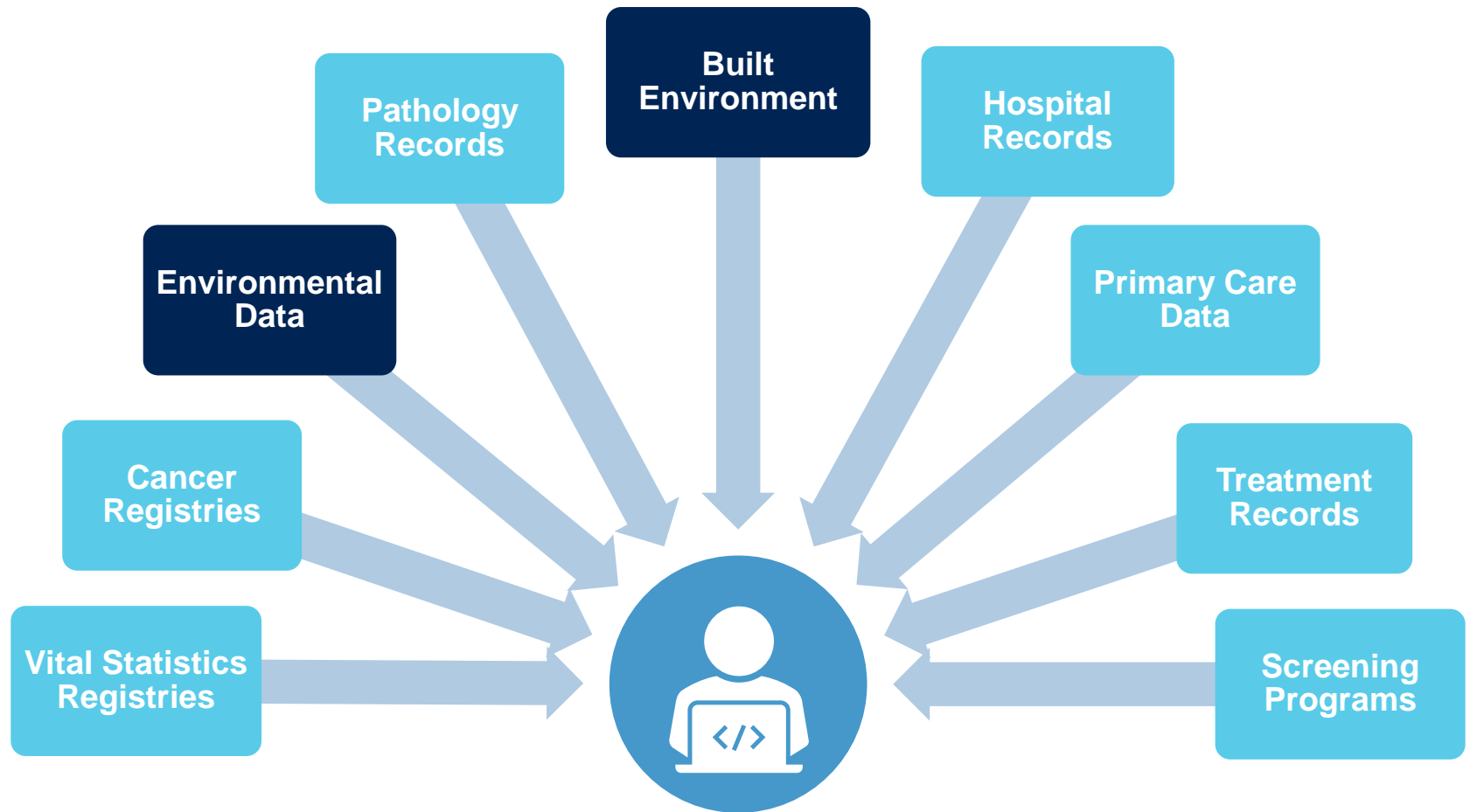
DASH is one of the first initiatives of HDRN Canada, which is made up of provincial, territorial and federal organizations which hold and manage data.

DASH is a single-stop online portal for requesting access to multi-jurisdictional Canadian data, and includes:

- An inventory of 380+ datasets available for request
- 140+ multi-jurisdictional algorithms
- An inventory of data access processes at HDRN Canada sites



Data linkages enable us to evaluate our cohort in real-time

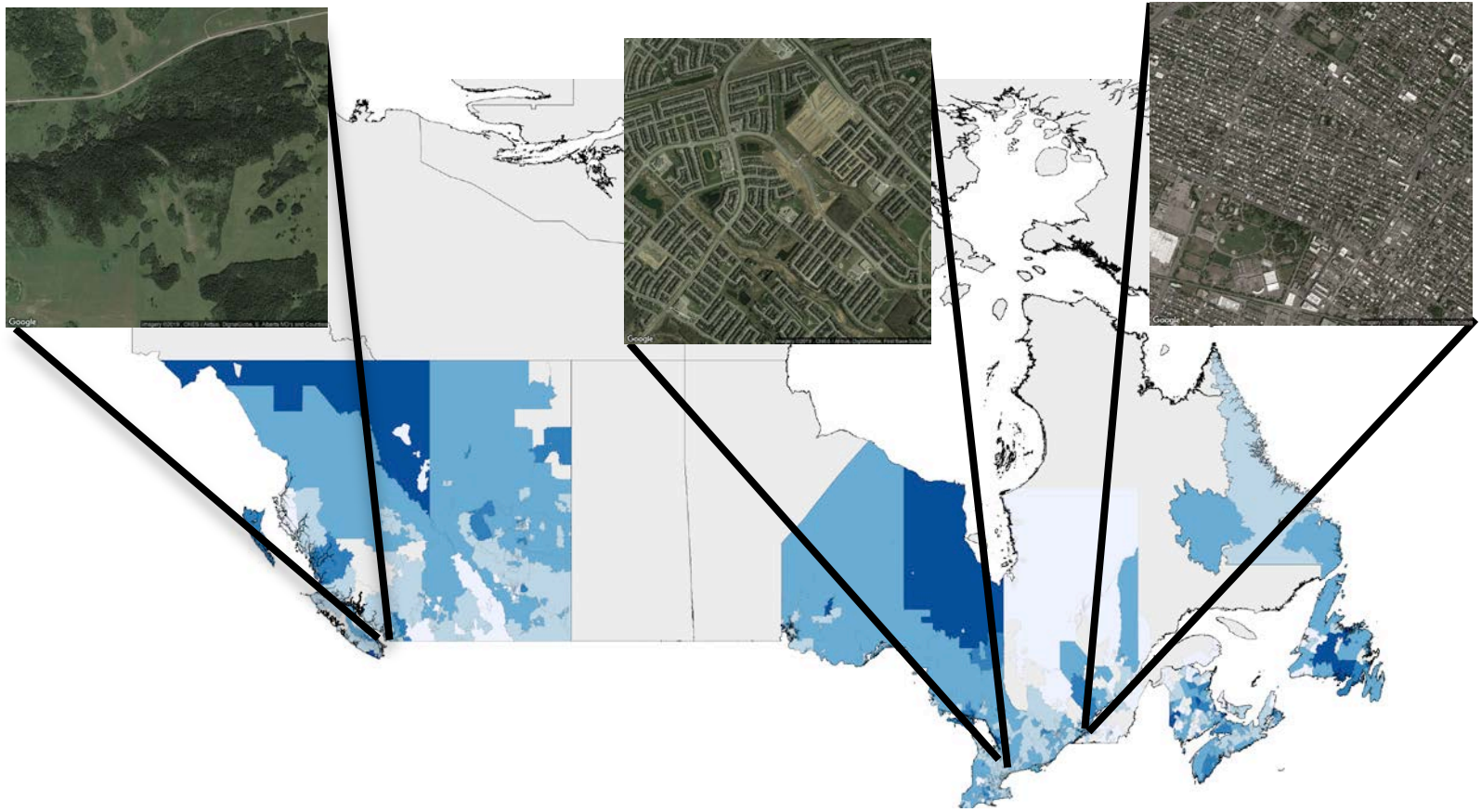


The Canadian Urban Environmental Health Research Consortium

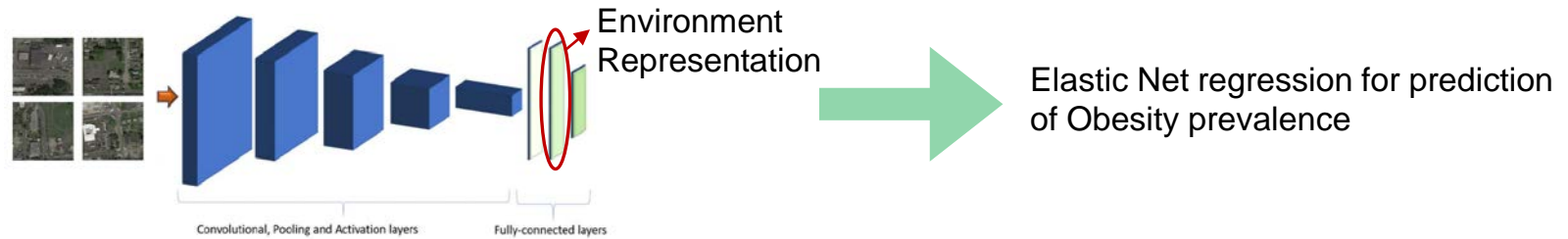
- All CanPath participants have been linked to CANUE environmental exposures
- Every location in Canada can be described by a complex set of environmental factors
- CANUE is building the capacity to study how these multiple **environmental factors are linked to a wide range of health outcomes**



The Canadian Urban Environmental Health Research Consortium

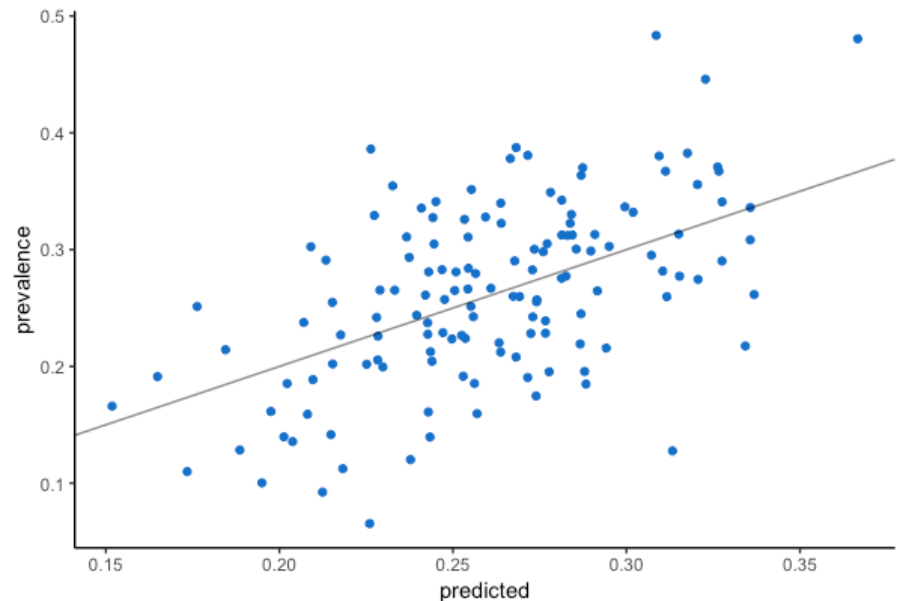


Deep learning can extract natural and built environment information from satellite images



Predicted vs real Prevalence from Ontario FSA using Elastic Net regression on the extracted features from the CNN - test set



$R^2 \sim 0.3$



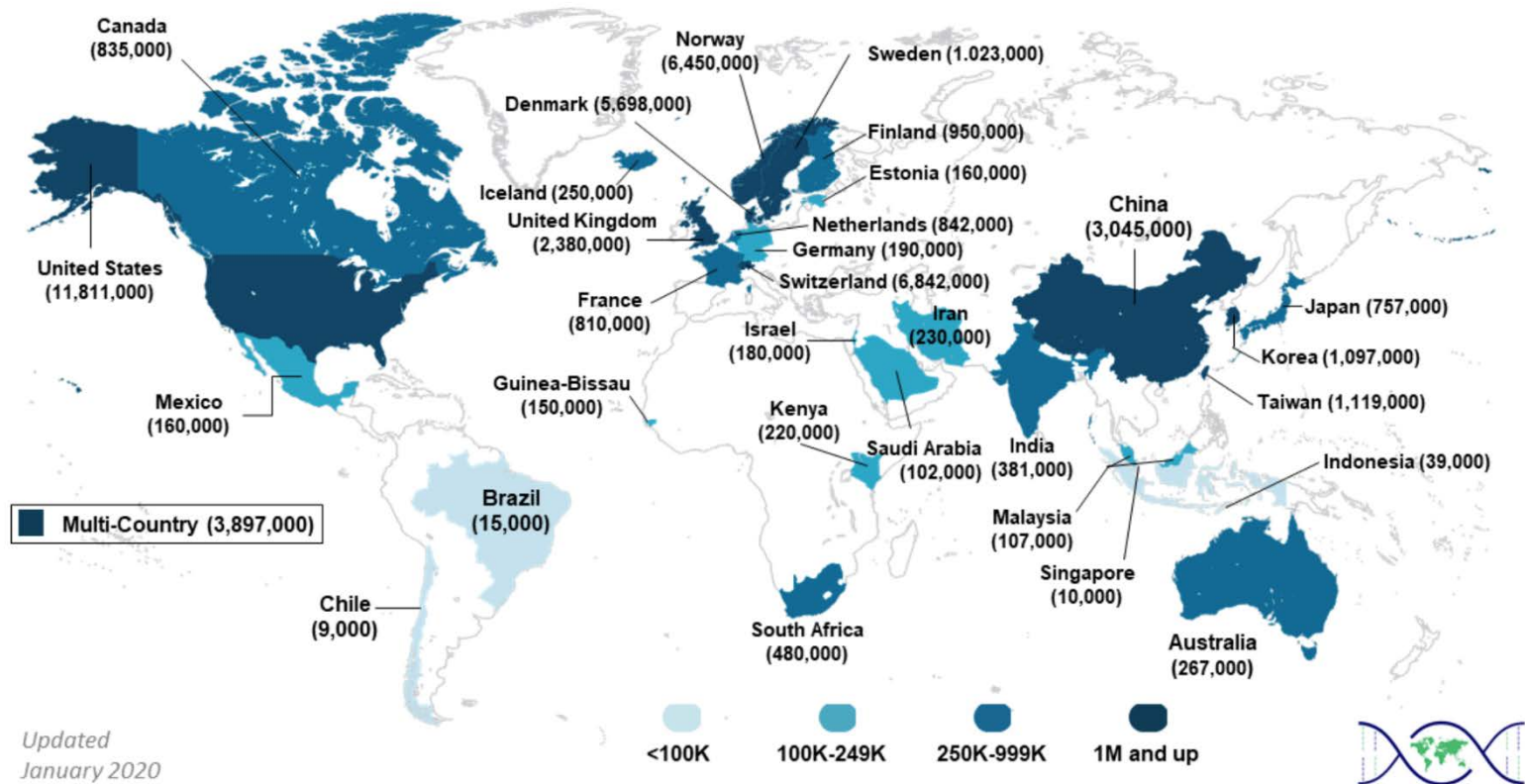
CanPath integration with international efforts

CanPath is an internationally recognized **large-scale precision medicine initiative** (100,000+ participants) working with other large cohorts around the world through the International Hundred Thousand Cohort Consortium (IHCC) including:

CanPath is
Canada's
largest
population
health
cohort

23andMe 
Biobank Japan 
China Kadoorie Biobank 
Canadian Partnership for Tomorrow's Health (CanPath) 
EPIC 
Kaiser Permanente Research Program 
LifeGene 
Million Veteran Program 
Million Women Study 
Multiethnic Cohort Study 
MyCode Community Health Initiative 
Nurses' Health Study (NHS/NHSII) 
US Precision Medicine Initiative/All of Us 
Tohoku Medical Megabank Project 

CanPath integration with international efforts



International 100K Cohort Consortium (IHCC)

Linking cohorts, understanding biology, improving health

CanPath in the Canadian cohort landscape

N participants

CanPath (Canadian Partnership for Tomorrow's Health)	~ 330,000
CLSA (Canadian Longitudinal Study of Aging)	~ 50,000
MIREC (Maternal Infant Research on Environmental Chemicals)	~ 2000
CHILD (Canadian Healthy Infant Longitudinal Development)	~3450

Examples of alternative platforms:

Canadian Health Measure Survey (5 cross-sectional surveys)	~ 29,000
Canadian Community Health Survey (X-S survey every 2 yrs)	~ 65,000



CanPath

Canadian Partnership
for Tomorrow's Health

**Launches
CanPath
COVID-19
Initiative**

CanPath COVID-19 Initiative

- Leverages existing infrastructure to determine **population-level prevalence** of COVID-19;
- Determine **biological, societal and behavioural factors** that affect susceptibility to COVID-19;
- Capture the **socio-economic and mental health and long-term health outcomes** of COVID-19

CanPath is a member of The COVID-19 Host Genetics Initiative

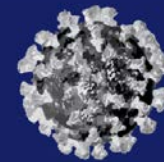


COVID-19 Host Genetics Initiative

Brings together the human genetics community to generate, share and analyze data to learn the genetic determinants of COVID-19 susceptibility, severity and outcomes

195 contributing studies from around the world are seeking to:

1. Provide an environment to foster the sharing of resources to facilitate COVID-19 host genetics research (e.g. protocols, questionnaires);
2. Organize analytical activities across studies to identify genetic determinants of COVID-19 susceptibility and severity;
3. Provide a platform to share the results from meta-analytical activities to benefit the broader scientific community.

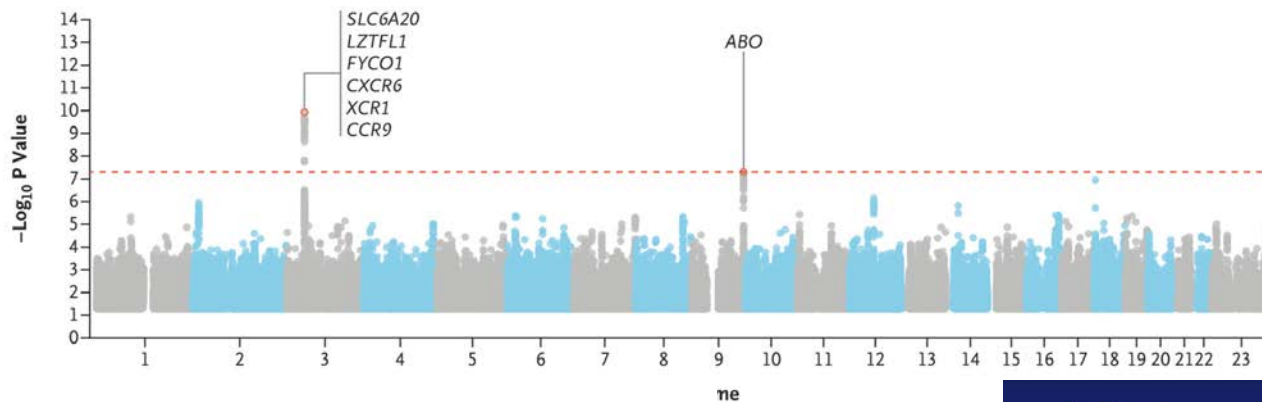


The COVID-19
Host Genetics Initiative

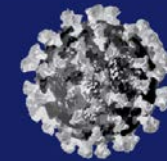
COVID-19 Host Genetics Initiative

Brings together the human genetics community to generate, share and analyze data to learn the genetic determinants of COVID-19 susceptibility, severity and outcomes

Genome-wide Association Study of Severe Covid-19 with Respiratory Failure (David Ellinghaus, D. et al. 2020. *NEMJ.*)



The NEW ENGLAND
JOURNAL of MEDICINE

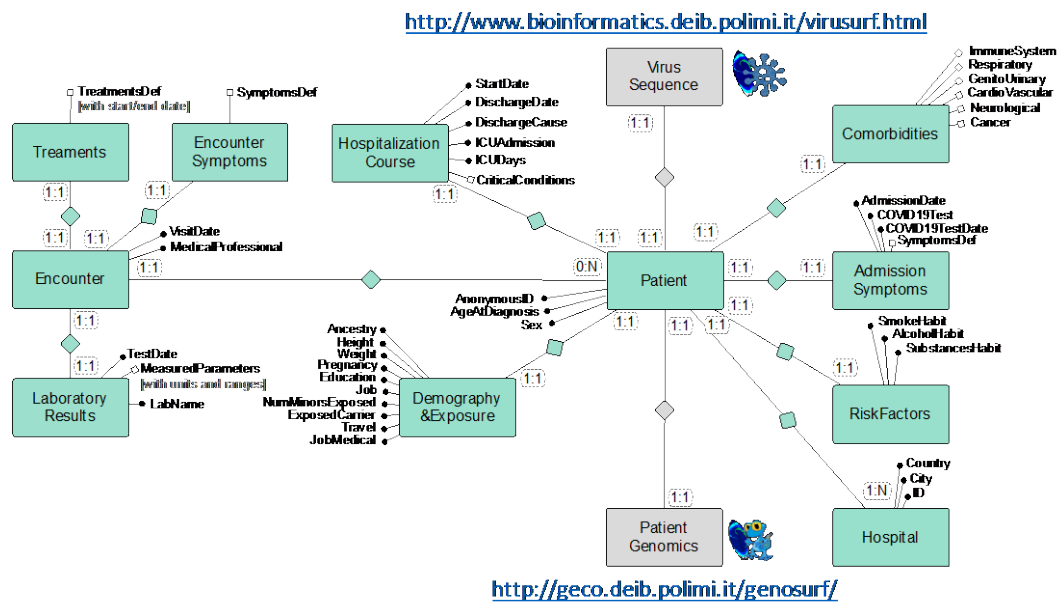
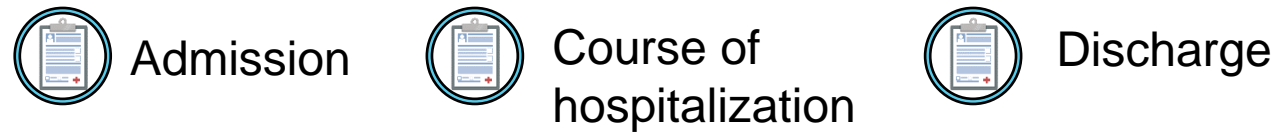


The COVID-19
Host Genetics Initiative

COVID-19 Host Genetics Initiative

Construction of a **patient phenotype definition** that will be used to collect and harmonize data from studies around the world.

Phenotypes are collected at the point of:



Data will be hosted by **EGA** (European Genome-phenome Archive) of EMBL-EBI

Access current version at:
[FREEZE-1 DATA](#)
[DICTIONARY](#)



Clonal Hematopoiesis COVID-19 Subgroup

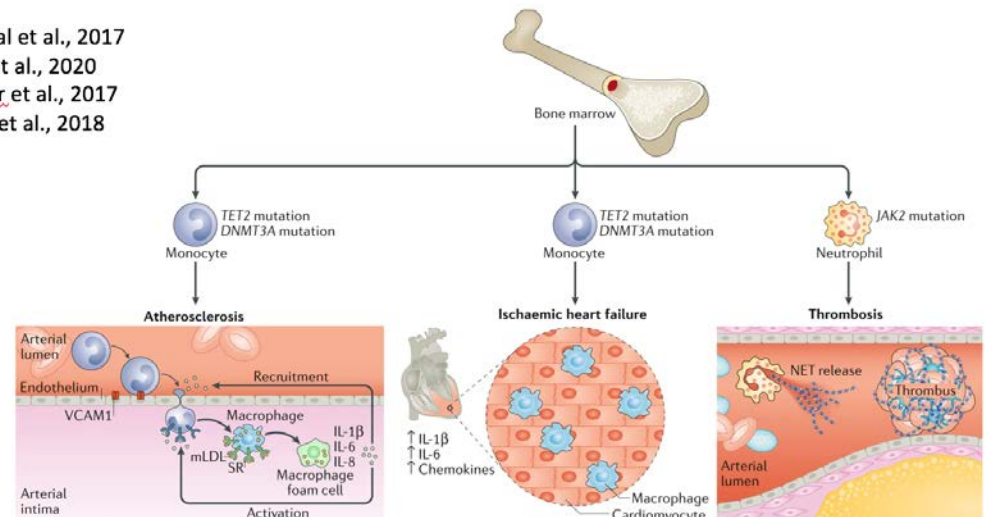
Leads: Kelly Bolton, Philip Awadalla & Pradeep Natarajan

Objectives:

1. **Share resources and experience** to facilitate COVID-19 CH research
2. **Organize and coordinate** COVID-19 CH analytical studies participating in the COVID-19 HG
3. Provide a platform to **share research findings**

Clonal hematopoiesis alters the inflammatory landscape of circulating blood cells

Jaiswal et al., 2017
Bick et al., 2020
Fuster et al., 2017
Sano et al., 2018



CanPath COVID-19 questionnaire has been designed to align with international efforts



COVID-19 test result/ suspected infection



Symptoms experienced (if any)



Participant hospitalized or received medical care



Current health status and risk factors for COVID-19



Potential source of exposure



Impact of pandemic on job status



Impact of the pandemic on mental, emotional, social and financial wellbeing

Over 30,000 questionnaires have been completed nationally

Questionnaires Completed as of June 19, 2020:



32,457



23,604



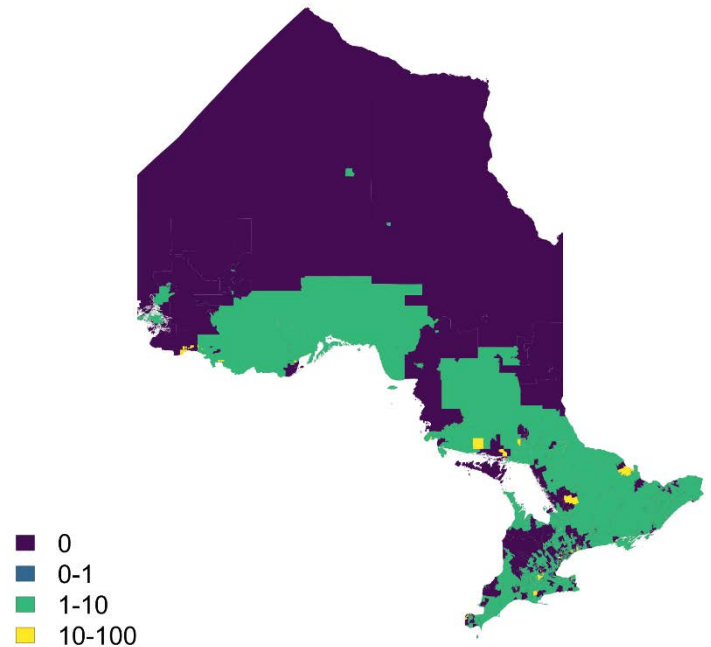
4,453



4,400

Questionnaire to be launched in BC, Manitoba and Atlantic provinces in the coming days.

Proportion of population tested across Ontario



Over 30,000 questionnaires have been completed nationally

Questionnaires Completed as of June 19, 2020:



32,457



23,604



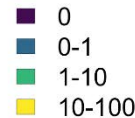
4,453



4,400

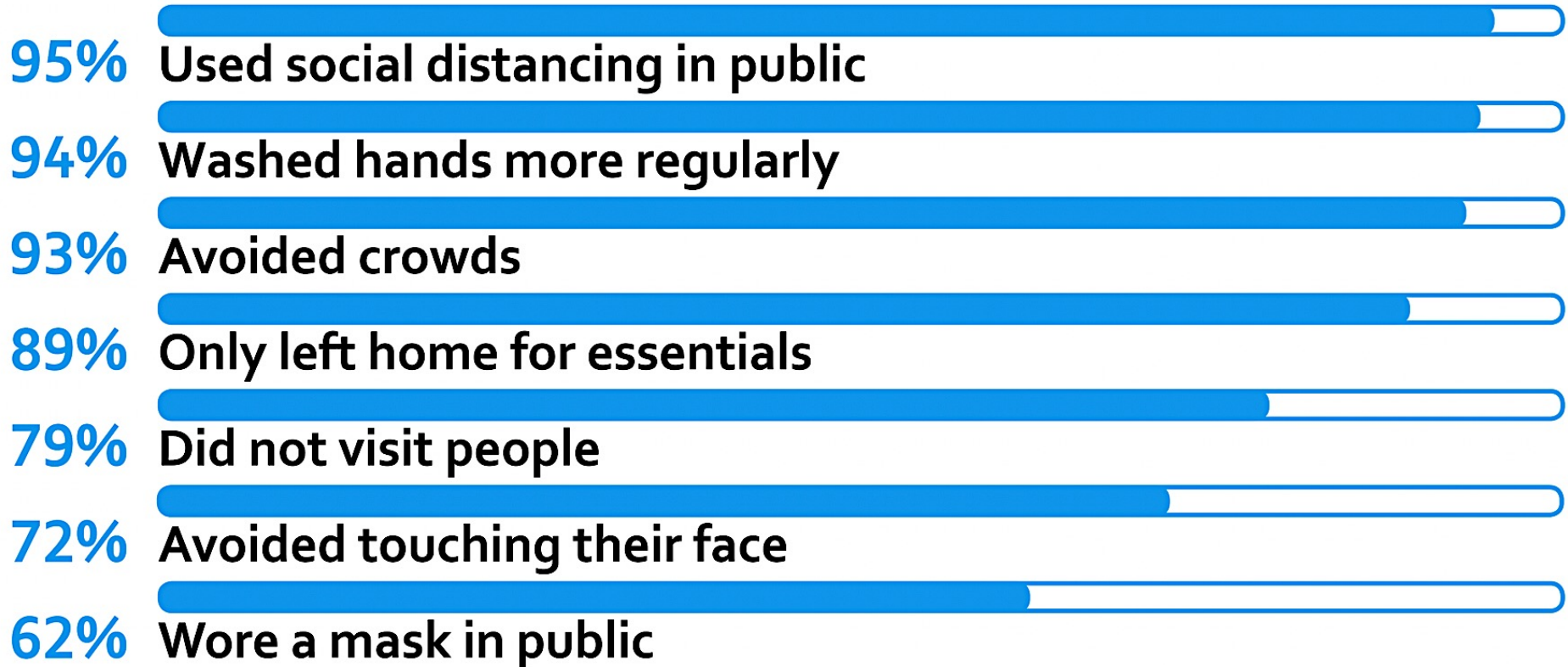
Questionnaire to be launched in BC, Manitoba and Atlantic provinces in the coming days.

Proportion of population tested across GTA



Over 20,000 questionnaires have been completed in Ontario

Participants reported taking the following precautions*:



SUPPORT-Canada: A national COVID-19 serological surveillance study



Population Cohorts



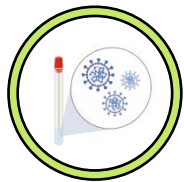
Patient Cohorts



Healthcare Workers



Collection of COVID-19 related data and outcomes from 420,000 Canadians



Longitudinal serological surveillance of diagnosed, symptomatic and asymptomatic Canadians



Deep sequencing to support functional immunogenomics studies

Accessing CanPath Data

www.portal.canpath.ca

[English / Français](#) [News & Events](#) [Register | Login](#)

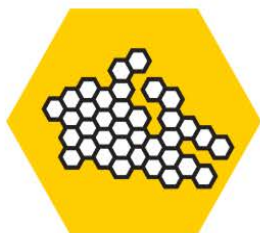
[Home](#) [Cohort](#) [Data](#) [Biosamples](#) [Access -](#) [Search](#) [Contact Us](#)

CanPath Portal



The Canadian Partnership for Tomorrow's Health (CanPath) Portal provides the research community with the necessary resources to identify epidemiological and biological data available from five participating cohorts to answer innovative research questions. A request for access to CanPath data is initiated directly through the CanPath Portal.

Cohort



Find out more about the five regional cohorts of the CanPath.

[Read More](#)

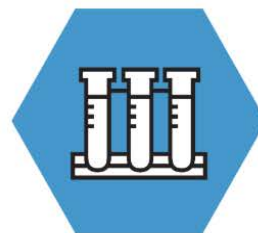
Data



Find out more about the CanPath datasets and data harmonization approach.

[Read More](#)

Biosamples



Find out more about CanPath's biological-sample collection and its upcoming availability.

[Read More](#)

Access



Find out more about CanPath Access Policy, the access process, and approved research projects.

[Read More](#)

CanPath

Accessing CanPath Data

[English / Français](#) [News & Events](#) [Register | Login](#)

[Home](#) [Cohort](#) **Data** [Biosamples](#) [Access](#) [Search](#) [Contact Us](#)



Data



CORE DATA

The core harmonized data includes information related to health and risk factors, mental health, physical measures and biological samples collected by the British Columbia Generations Project, Alberta's Tomorrow Project, Ontario Health Study, CARTaGENE (Quebec), Atlantic Partnership for Tomorrow's Health Study and Manitoba Tomorrow Project as core CanPath data content. The Manitoba Tomorrow Project is currently in recruitment and participant data is not yet ready for research.

[Read more](#)

1,477 Harmonized Variables

ENVIRONMENTAL EXPOSURE DATA

The CIHR-funded Canadian Urban Environmental Health Research Consortium ([CANUE](#)) collates and generates standardized area-level environmental data on air and noise pollution, land use, green/natural spaces, climate change/extreme weather, and socioeconomic conditions and links this data to existing Canadian cohort studies and administrative health databases. An initial batch of CANUE exposure datasets have been merged with the national harmonized CanPath dataset and are now available to researchers. These datasets include:

- Canadian Active Living Environments Database (Can-ALE)
- Material and Social Deprivation Index
- Normalized Difference Vegetation Index (NDVI; i.e. "greenness" metrics)
- Annual average nitrogen dioxide (NO2) exposure
- Annual average ozone (O3) exposure
- Annual average fine particulate matter (PM2.5) exposure
- Annual average sulfur dioxide (SO2) exposure
- Weather and Climate metrics
- Satellite based nighttime light

[Read more](#)

104 Harmonized Variables

GENOTYPE DATA

Genotype data on more than 4,800 CanPath participants is now available for access. The genotype data provides information on over 820,000 SNPs (Affymetrix UK Biobank Axiom® 2.0 gene chip). Marker categories include disease markers, pharmacogenomics, Human Leukocyte Antigen (HLA), inflammation and Expression quantitative trait loci (eQTL) variants. This work was completed with the assistance of:

www.portal.canpath.ca

Accessing CanPath Data

English / Français News & Events

Register | Login

Home Cohort Data Biosamples Access - Search Contact Us

CanPath Portal



The Canadian Partnership for Tomorrow's Health (CanPath) Portal provides the research community with the necessary resources to identify epidemiological and biological data available from five participating cohorts to answer innovative research questions. A request for access to CanPath data is initiated directly through the CanPath Portal.

Cohort



Find out more about the five regional cohorts of the CanPath.

[Read More](#)

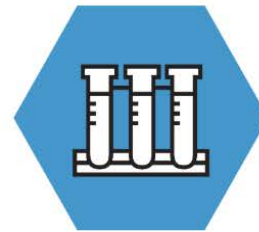
Data



Find out more about the CanPath datasets and data harmonization approach.

[Read More](#)

Biosamples



Find out more about CanPath's biological-sample collection and its upcoming availability.

[Read More](#)

Access



Find out more about CanPath Access Policy, the access process, and approved research projects.

[Read More](#)

Accessing CanPath Data

My Access Requests

[← New Access Request](#)

[Cancel](#) [Save](#) [Validate](#)

SCHEDULE A

CanPath Data and Biosamples Access Application Form

This Access Application Form is to be used by all researchers seeking access to Research Data and/or Biosamples, referred to as Material in the Data and Material Sharing Agreement. Please refer to the CanPath Access Policy for the meaning of all capitalized terms used in this form, which is available on the CanPath portal.

Applicants should review the **Access Policy**, **Publications Policy** and **Intellectual Property Policy** in the [CanPath Policies & Guidelines Section \(Access Process Page\)](#) before completing this Access Application Form.

Applicants must complete all mandatory sections and provide supporting documentation before the access request will be considered. Further information on CanPath's review and approval process can be found in the Access Policy.

Upon approval of an access request by the Access Committee, access to Research Data and/or Material will be granted for the timeframe set out in the approved Access Application Form and the Access Agreement. An Annual Progress Report must be completed to access and use Research Data and/or Material beyond a one-year period.

The title of the Approved Research Project, name(s) of the Approved User and Research Team involved, their status and credentials, name(s) of the Approved Institution(s), and a lay summary of the scientific abstract submitted by the Applicant will be added to the public CanPath Access Registry.

I – Contact and Research Project Information

A. Name, institution, and contact details of the Applicant (Principal Applicant)

Please include a full postal address and a valid institutional e-mail address. If you have more than one affiliation, only provide the contact information pertaining to the institution you are affiliated with for the purpose of the research project.

Name

Credentials (PhD, MD, etc.)

Position (Rank, Faculty, Department)

Institution

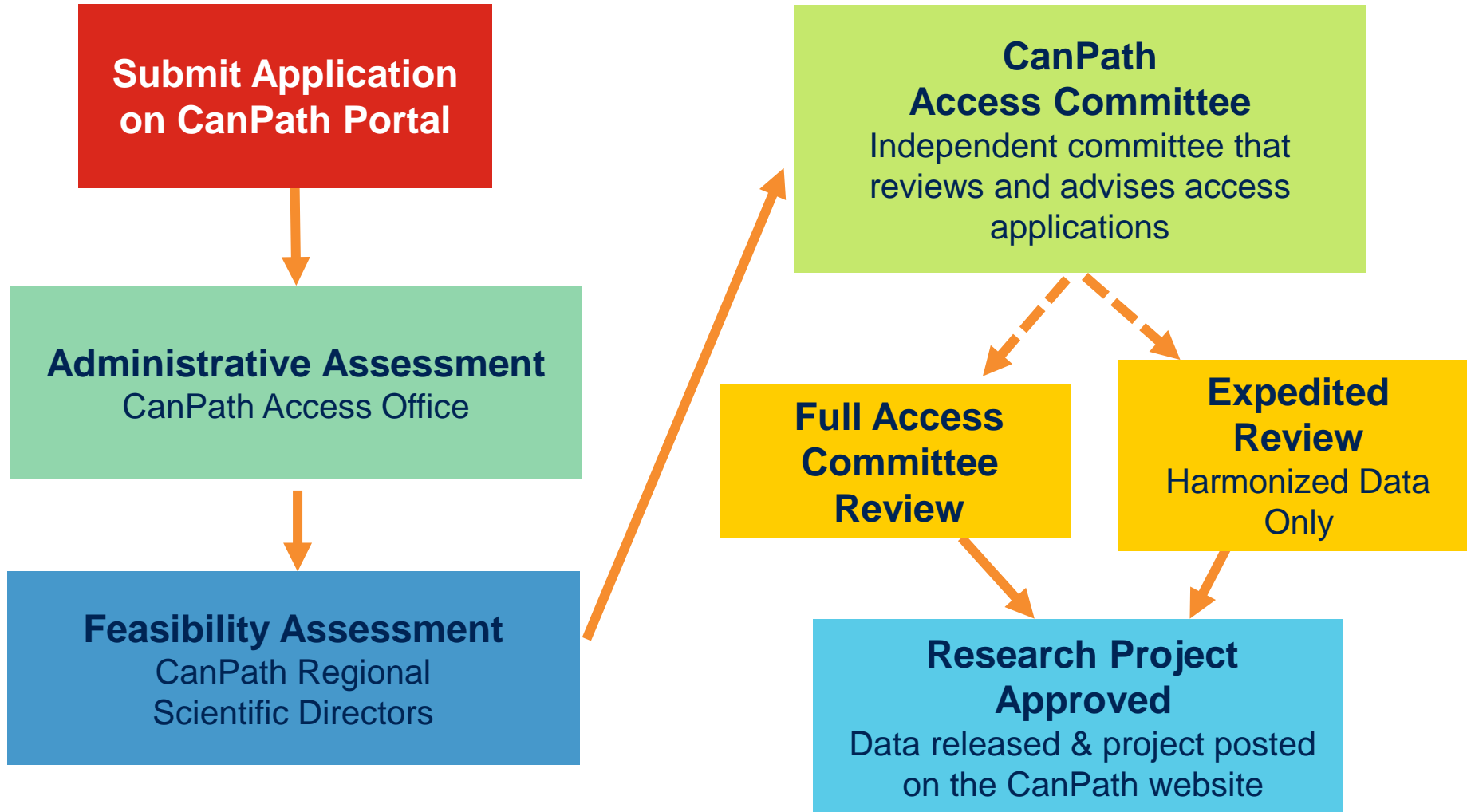
Institutional E-mail Address

Alternate E-mail Address

Telephone Number

Institutional Mailing Address

Access Review Overview



National Coordinating Centre

Based at the Dalla Lana School of Public Health, University of Toronto



Dr. Philip Awadalla
National Scientific Director

[Profile](#)



Dr. John McLaughlin
Executive Director

[Profile](#)



Tedd Konya
Project Manager

[Profile](#)



Asha Mohamed
Access Officer

[Profile](#)



Arlette Bax
Communications and
Knowledge Translation Officer

[Profile](#)



Mark Bhola
Administrative Assistant

[Profile](#)



Kim Skead
National Scientific Coordinator

[Profile](#)



Treena McDonald
National Biosample
Coordinator

[Profile](#)



Thank you to CanPath participants across the six regional cohorts who generously donate their time, information and biological samples. **CanPath is a success because of the participants' ongoing commitment.**

Thank you to our sponsors and hosts!



Everyone Counts.



CanPath.ca



CanPath

Canadian Partnership
for Tomorrow's Health

Partenariat canadien
pour la santé de demain