The Ontario Health Study:

A resource for cancer, disease and health research in Ontario and Canada

Prosserman Centre for Population Health Research (PCPHR) Rounds

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September 18, 2024

What is the Ontario Health Study (OHS)?

The OHS is a **longitudinal cohort study,** where study participants are followed over time via questionnaires, biological samples, and other forms of data collection.
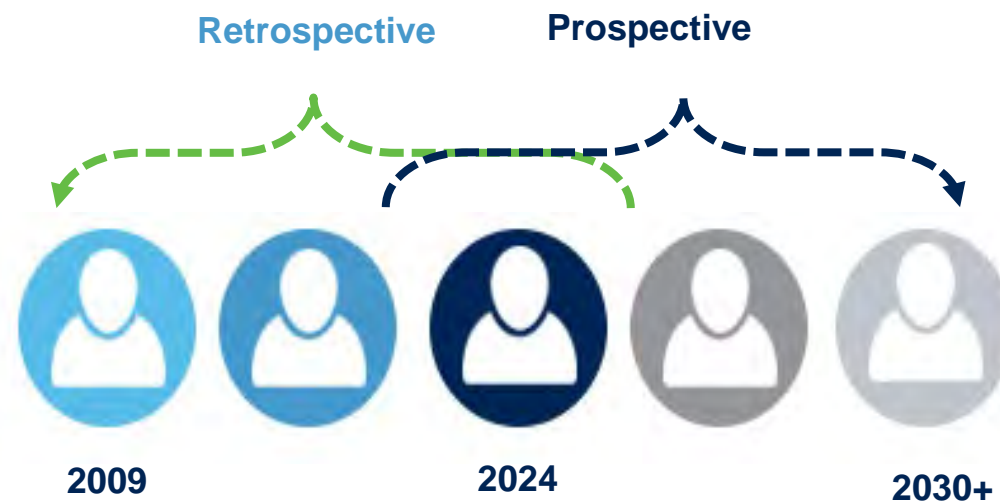
The Study examines how **lifestyle, the environment and genetics** interact to affect people's health.
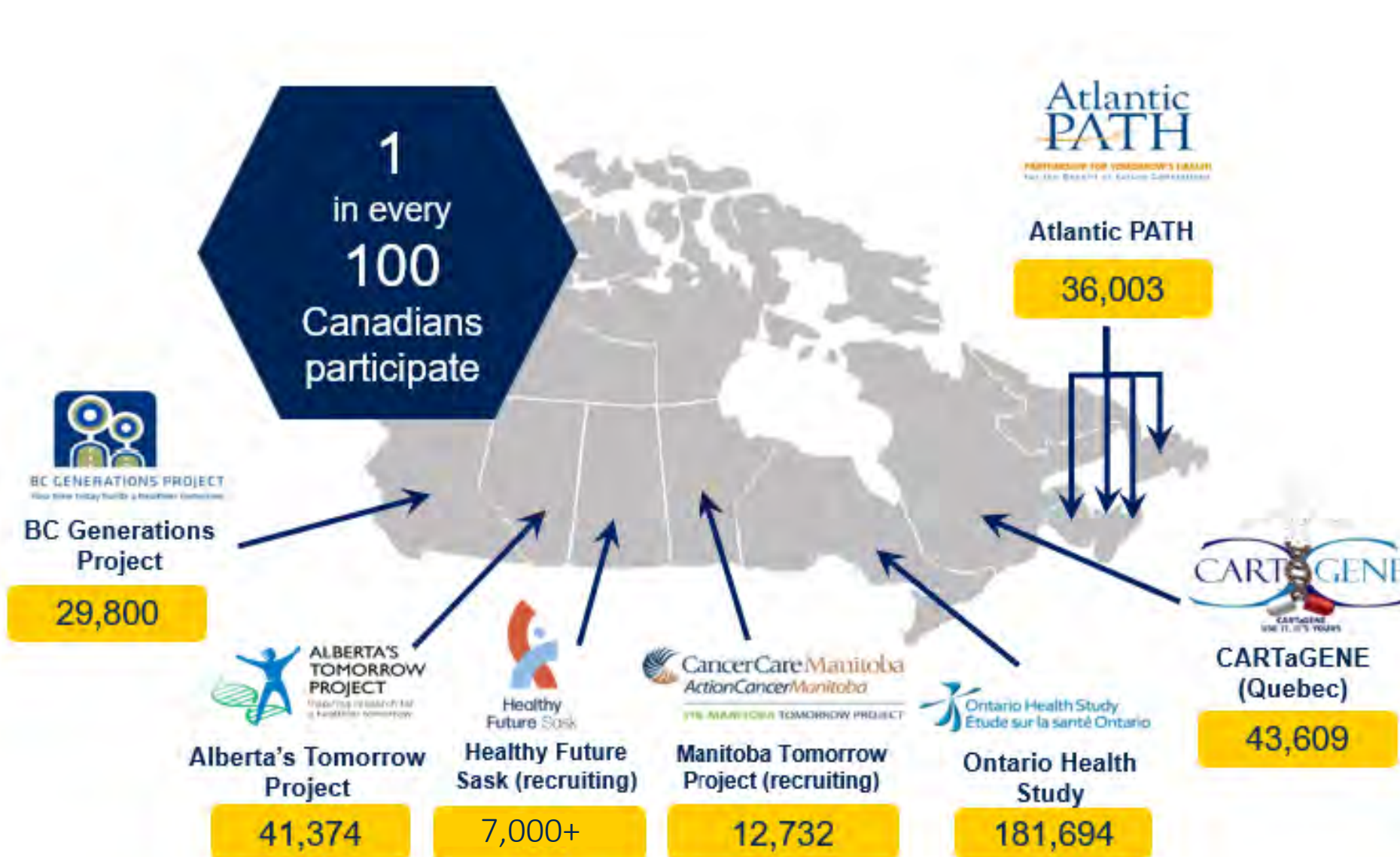
The OHS makes the data and biosamples of its **225,000 participants** available to researchers investigating cancer and other conditions.

Enabling research breakthroughs

- enables research across health domains to improve disease **prevention, detection, treatment and health services**

- data and biological samples are available to researchers to study **a wide range of exposures (environment, lifestyle, etc.)** and **outcomes (common chronic disease, rare disease, infectious disease, etc.)**

- enables scientists to perform health-related research **today and for years to come**

Retrospective — Prospective

2009 — 2024 — 2030+

Part of Canada's largest population health research platform

1 in every 100 Canadians participate

BC Generations Project
29,800

Alberta's Tomorrow Project
41,374

Healthy Future Sask (recruiting)
7,000+

Manitoba Tomorrow Project (recruiting)
12,732

Ontario Health Study
181,694

Atlantic PATH
36,003

CARTaGENE (Quebec)
43,609

The Ontario Health Study is the largest contributing member of **CanPath**, the Canadian Partnership for Tomorrow's Health.

What does the OHS have available?

~225,000 participants, of which **>181,600** are part of CanPath

>188,000 participants linked with administrative databases

>40,000 non-fasting blood samples (plasma, serum, RBC, buffy coat)

>12,800 physical assessments
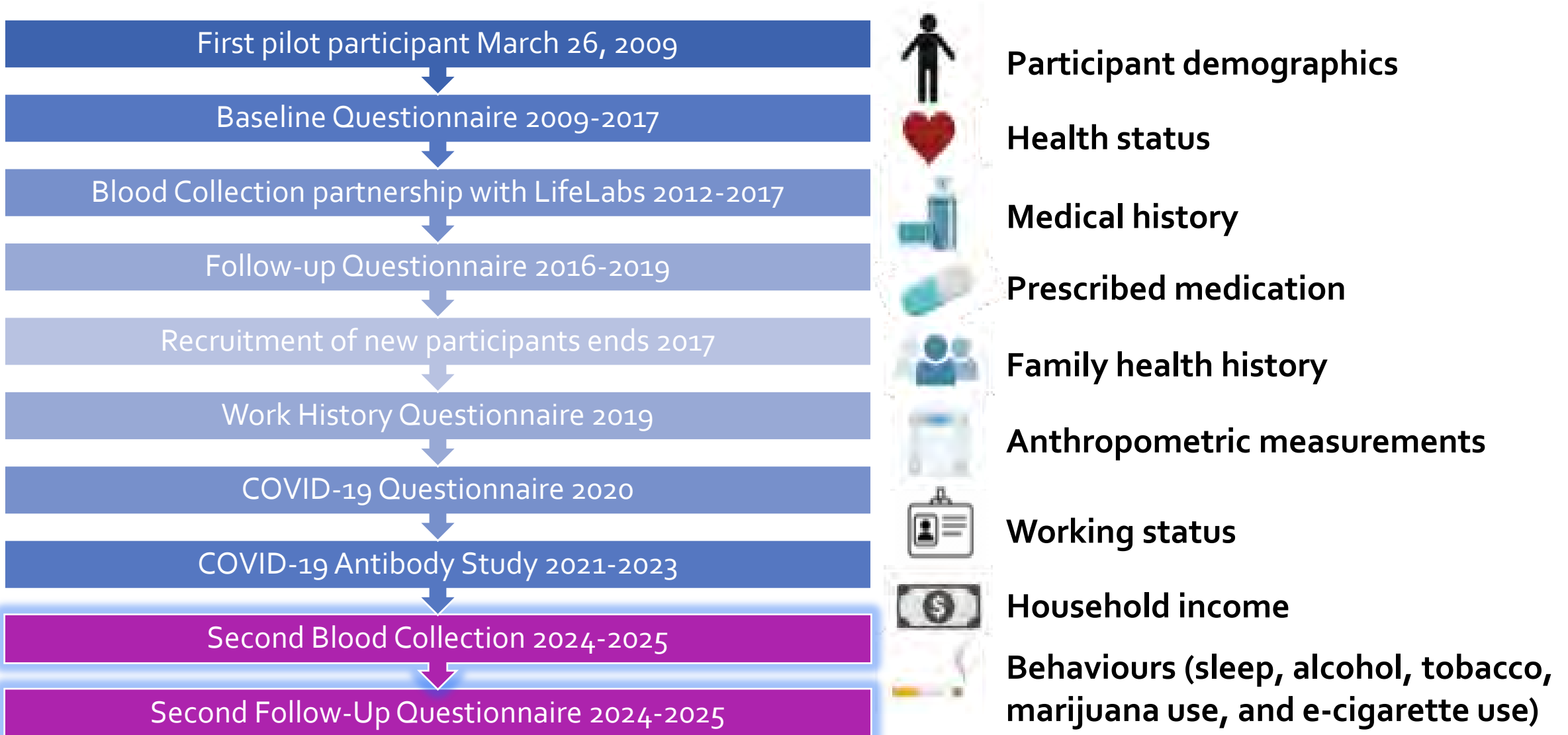
~12,600 urine samples

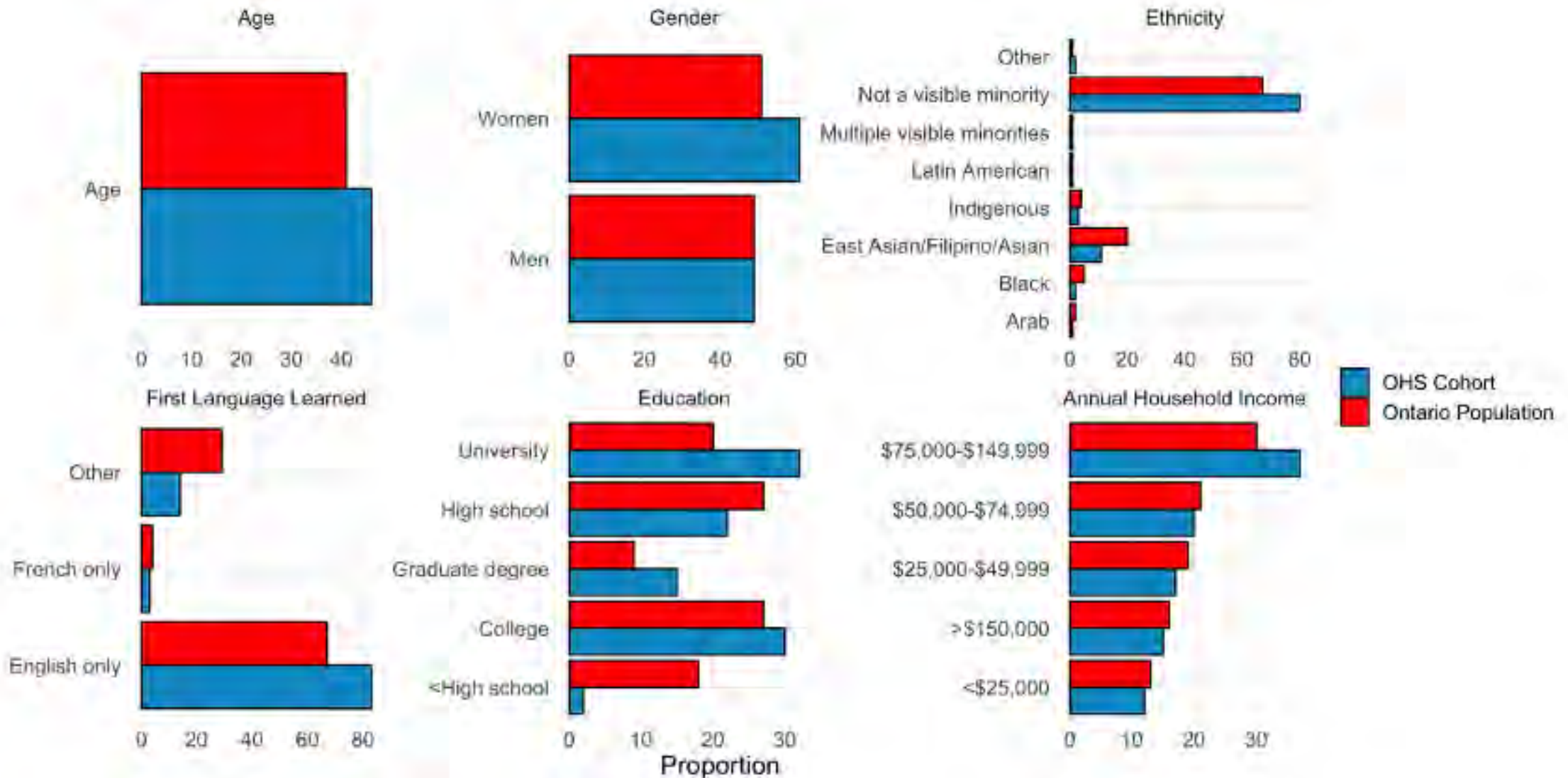**~3,100** MRIs, cognitive assessments

~20,000 participants genotyped

>23,600 participants diagnosed with cancer

Ongoing data and biospecimen collection

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Timeline of data and biospecimen collection

First pilot participant March 26, 2009

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Baseline Questionnaire 2009-2017

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Blood Collection partnership with LifeLabs 2012-2017

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Follow-up Questionnaire 2016-2019

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Recruitment of new participants ends 2017

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Work History Questionnaire 2019

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COVID-19 Questionnaire 2020

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COVID-19 Antibody Study 2021-2023

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Second Blood Collection 2024-2025

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Second Follow-Up Questionnaire 2024-2025

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)

Sociodemographic characteristics of the OHS in comparison to the Ontario Census population (2016)

Geographic Distribution of Ontario Health Study
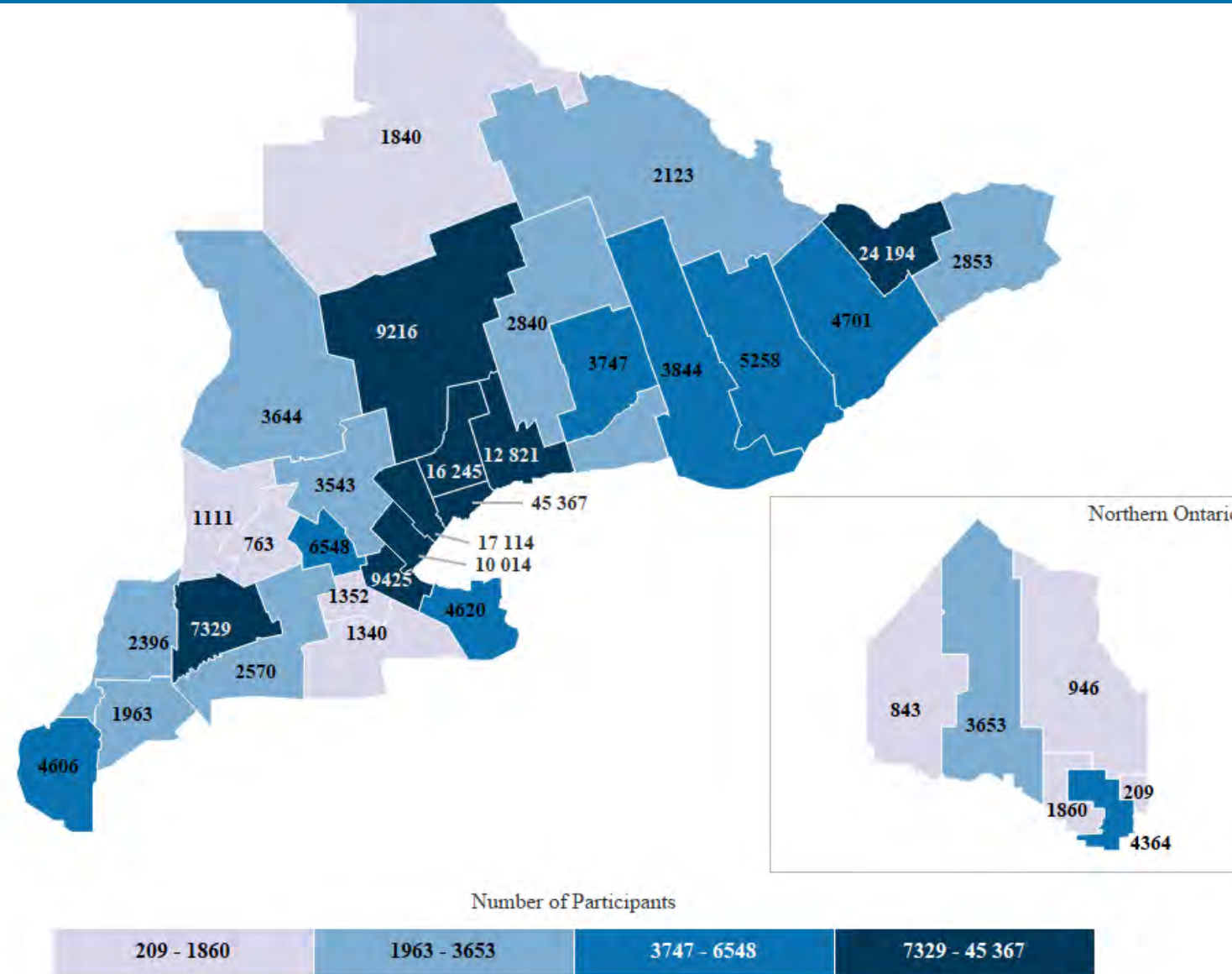
Kirsh et al. 2023, Int. J. Epi.

Biosamples and analytic data available for access

Timepoint	Specimen Type		Maximum Amount/ Participant	Aliquots	# of Participants
Baseline (2009 – 2017)	Blood	Plasma	1.5-4.5 mL	1-3 cryovials (1.5 mL)	40,056
		Serum	1.5-4.5 mL	1-3 cryovials (1.5 mL)	
			2.4 mL	6 cryovials (0.5 mL)	
		RBCs	1.5 mL	1 cryovial (1.5 mL)	
		Buffy Coat	0.75-1.0 mL	1 cryovial (1.8 mL)	
		Lymphocytes	1.0 mL	1 cryovial (1.0 mL)	5,962
	Urine		3 mL	2 cryovials (1.5 mL)	12,600
	DNA (Buffy Coat)			Up to 1.5ug	24,563
2020 - 2023	Dried Blood Spots		Up to 3	N/A	9,956

Timepoint	Data	# of Participants
Baseline: Immediate Blood analysis	Complete Blood Count (CBC)	31,442
	Glycosylated hemoglobin (HbA1c)	
Ongoing	Genotyping (UKBIObank Affymetrix arrays)	~20,000
	Inflammatory markers (cytokines)	1,440
	scRNA Sequencing	~400
Antibody Study	Anti-N IgG levels (anti-SmT1, anti-RBD, anti-N)	9,956

Reported medication usage

- **224,771** participants completed the OHS baseline questionnaire.

- **89,637 (39.9%)** listed at least one medication in response to question "*Are you currently taking any medications prescribed by a doctor and dispensed by a pharmacist?*"

- Top **10** frequently-prescribed medications:

Rank	Medication	Indicated Use
1	Synthroid	Hypothyroidism
2	Apo-Atorvastatin	Statin (CVD, blood pressure)
3	Crestor 10 mg	Statin (Rosuvastatin)
4	Eltroxin	Hypothyroidism
5	Coversyl	ACE inhibitor (CVD, blood pressure)
6	Crestor 20 mg	Statin (Rosuvastatin)
7	Apo-hydro	Anti-hypertensive; diuretic
8	Teva-hydrochlorothiazide	Anti-hypertensive; diuretic
9	Celebrex	COX2-Inhibitor NSAID
10	Apo-salvent	Bronchodilator (Asthma)

Linkages with OHS Data

188,000+ OHS participants recruited between 2009 and 2017 have been linked to Ontario Health and ICES data holdings

- Within OH holdings, the **Ontario Cancer Registry** captures:
    - Hospital admission and discharge information from CIHI
    - Pathology reports from hospitals and community labs
    - Consultation and treatment records of patients from regional cancer centres or their associated hospitals
    - Death certificates
- Incident cancer cases ascertained via record linkage and staged according to the TNM classification system

- Data sets available through ICES include:
    - Hospital Discharge Abstract Database (DAD)
    - National Ambulatory Care Reporting System (NACRS)
    - Continuing Care Reporting System (CCRS)
    - Ontario Drug Benefit Claims (ODB)
    - Ontario Health Insurance Plan Claims Database (OHIP)
    - Registered Persons Database (RPDB)
    - Ontario Cancer Registry (OCR)
    - Ontario Laboratory Information System (OLIS)

Most commonly-diagnosed cancers in cohort

Cancer Type	Total (N=188,351)[a]			Provided blood (N=38,799)		
	Prevalence[b]	Incidence[c,d]		Prevalence[b]	Incidence[c,d]	
	n	n	Per 100,000 person-years	n	n	Per 100,000 person-years
Breast (female)	2535	1870	190.2	926	415	263.3
Prostate	2194	1699	266.3	683	456	441.9
Skin (melanoma)	972	834	50.1	315	204	74.9
Colorectal	960	969	58.2	275	167	61.2
Thyroid and other endocrinal	829	522	31.3	285	93	34.1
Lymph node	653	335	20.1	191	77	28.1
Haemotologic	469	956	57.2	139	217	79.3
Uterine	468	540	53.6	176	134	81.8
Bladder	321	580	34.7	97	126	46
Renal	312	357	21.3	104	73	26.6

a Includes participants who consented to administrative linkages; mean (SD) age in years is 47 (15) overall and 57 (10) among those who provided a blood sample.
b Ascertained through linkage with the Ontario Cancer Registry from 1 January 1964 through to date of enrolment; self-reported cancer history is also available.
c Ascertained through linkage with the Ontario Cancer Registry covering the period from baseline to 31 March 2021.
d Average follow-up time is 8.7 years; 1,634,839 total person-years of observation.

Common diseases and conditions identified through ICES
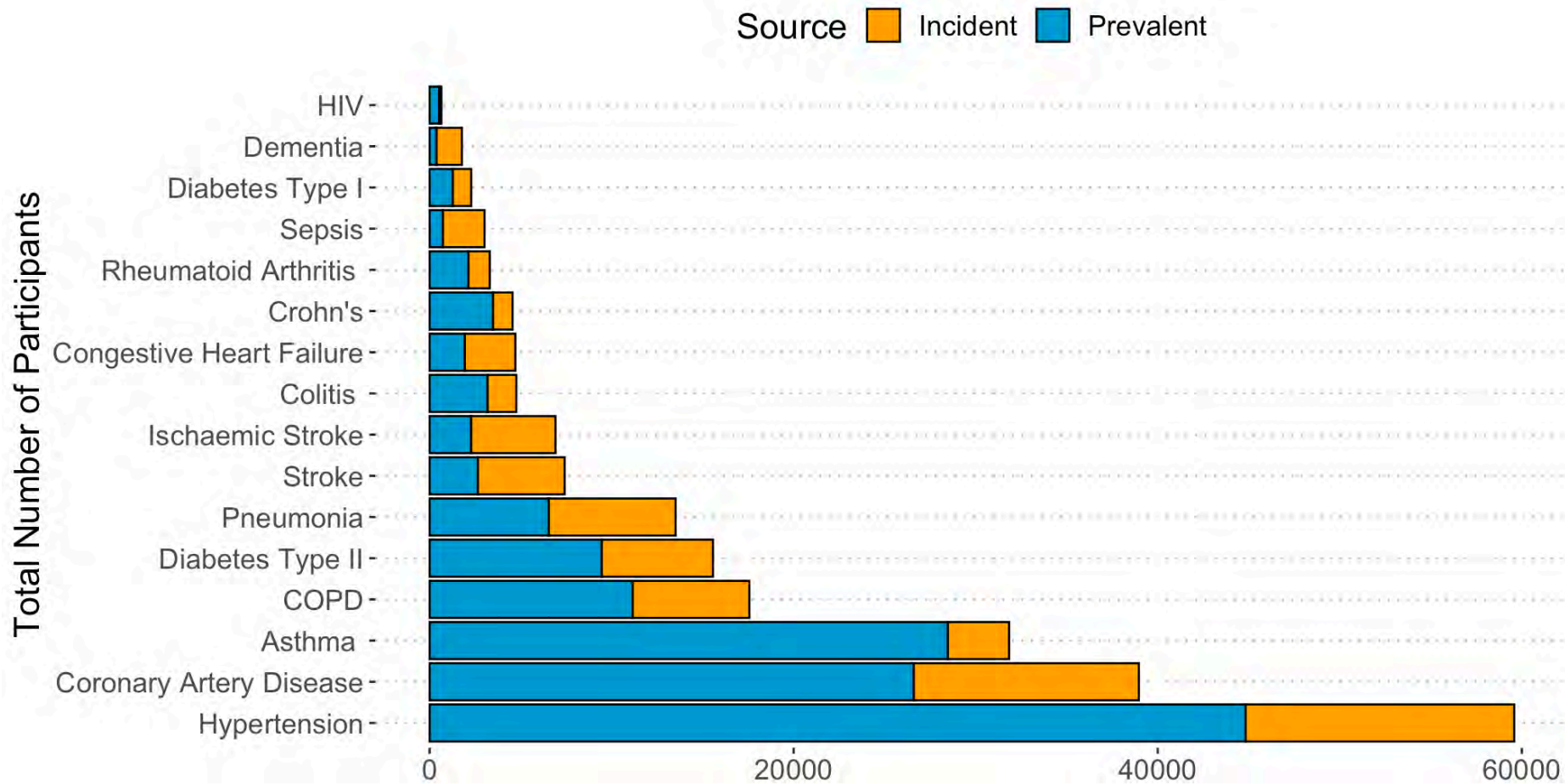
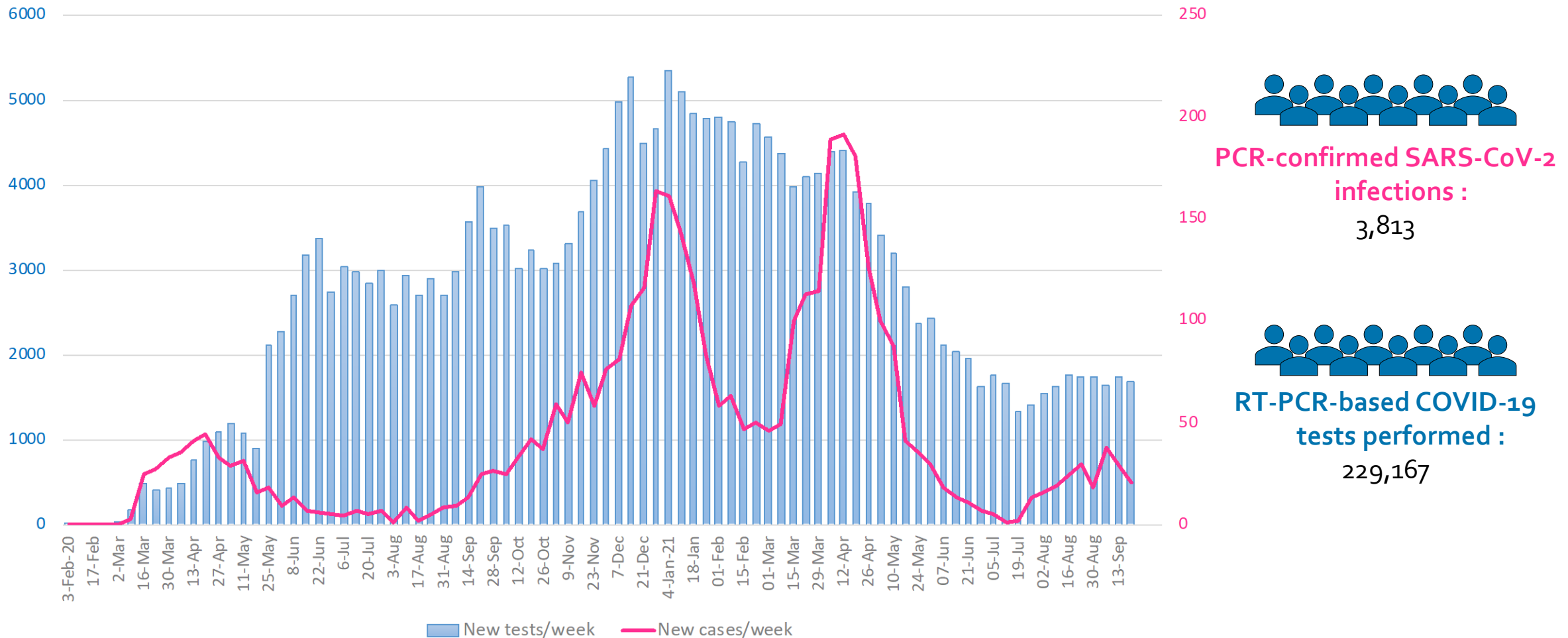Total Number of Participants:
225,000

Mean age at recruitment:
46.4 years
(SD = +/-15.0)

*Linkages reflect diagnoses captured up until March 2020 through Institute for Clinical and Evaluative Sciences (ICES)

COVID-19 cases identified through linkage to the Ontario Laboratory Information Systems (OLIS)

PCR-confirmed SARS-CoV-2 infections :
3,813

RT-PCR-based COVID-19 tests performed :
229,167

Legend: New tests/week | New cases/week

*Linkages reflect diagnoses captured from January 25, 2020 to September 20, 2021 through Institute for Clinical and Evaluative Sciences (ICES)

Linkages to The Canadian Urban Environmental Health Research Consortium (CANUE)

- All OHS participants have been linked to CANUE environmental exposures

- CANUE has built a database of environmental factors (e.g., **local air quality, amount of nearby traffic, access to greenspaces, walkability, social deprivation, climate, and weather**) dating back to the 1980s for each postal code in Canada

- Through Statistics Canada's Social Data Linkage Environment (SDLE) program, OHS participants' previous residences have identified through a residence reconstruction initiative using data from federal documents

- A platform to study climate change impact on the health

Select scientific discoveries supported by the OHS

- Low body mass index, high waist circumference, lower parity, and familial history of breast cancer, were associated with increased risk of **breast cancer diagnosed before age 50**. (Pader J et al., *Cancer Causes Control* 2021)

- Low fruit and vegetable intake and short or long sleep ($\leq$6 or >9 hrs/night, respectively) were associated with increased risk of **lung cancer among non-smokers**. (Murphy RA et al., *in submission* 2021)

- Diabetes was associated with MRI-identified vascular brain injury and cognitive impairment, implicating small vessel disease as an important link between **diabetes and cerebrovascular disease**. (Gerstein HC et al., *J Clin Endocrinol Metab* 2021)

- Atopic dermatitis was not associated with hypertension, type 2 diabetes, myocardial infarction or stroke, suggesting that it is not likely a major risk factor for **cardiovascular disease**. (Drucker AM et al., *Br J Dermatol* 2017)

- Increased total physical activity, vigorous-intensity activity, and walking were associated with decreased prevalence of **obstructive sleep apnea**. (Hall KA et al., *J Clin Sleep Med* 2020)

- Ethnocultural minorities were more likely to report suffering from **mental health** issues but less likely to access treatment. (Grace SL et al., *BMC Psychiatry* 2016)

- People who live in neighborhoods with a higher density of trees on their streets report significantly higher health perception and significantly fewer **cardiometabolic conditions**. (Kardan et al., *Sci Rep* 2015)

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Scientific discoveries (continued)

- Dr. Philip Awadalla is the Principal Investigator of the OHS, and co-leads CanPath as National Scientific Director

- The Awadalla Lab at OICR has several research projects going using OHS data:

PHD student using OHS data to look for early signs of cancer

Mar 3, 2023 // Study Updates
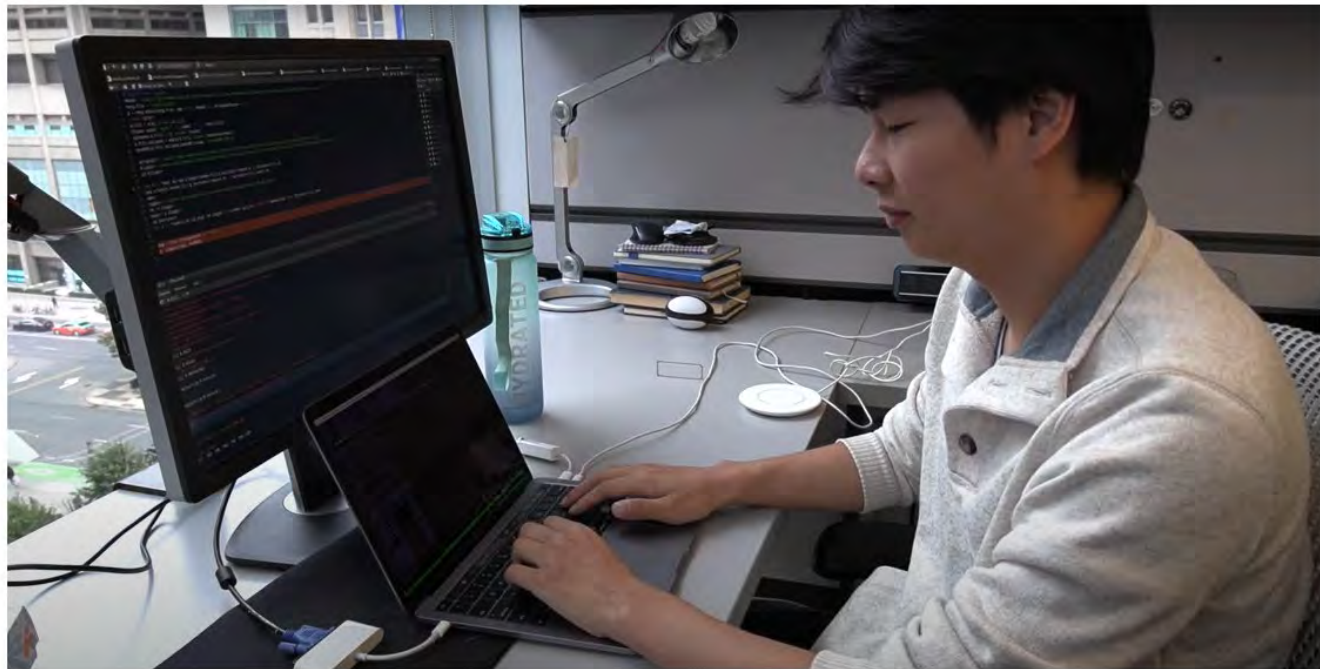
- Nicholas Cheng, a PhD student in the Awadalla Lab at OICR, used OHS data and biosamples to identify biomarkers in blood that allow for cancer detection up to **7 years earlier**
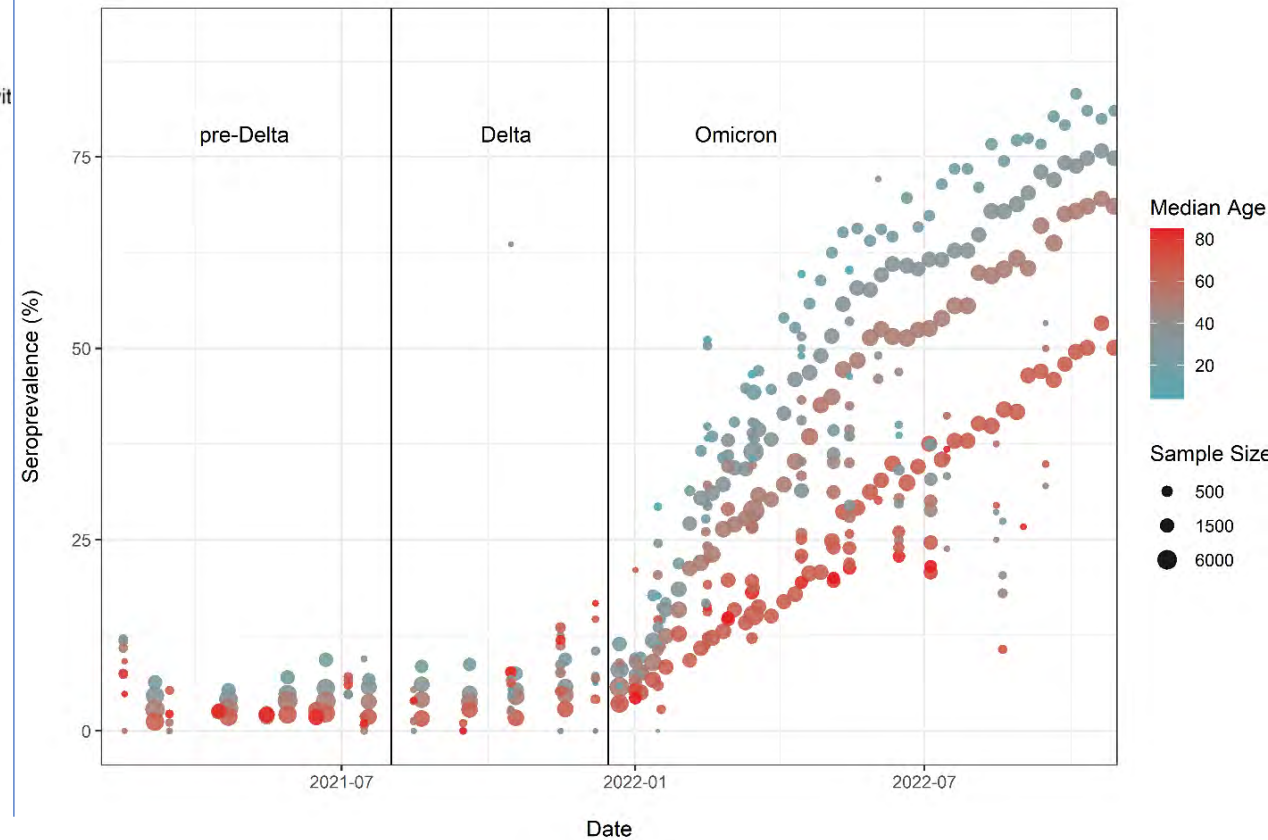
OICR
Ontario Institute
for Cancer Research

SARS-CoV-2 seroprevalence (Mar 2020 - Sep 2022)

Vaccine-induced and infection-acquired seropositivity for all age groups, by region:
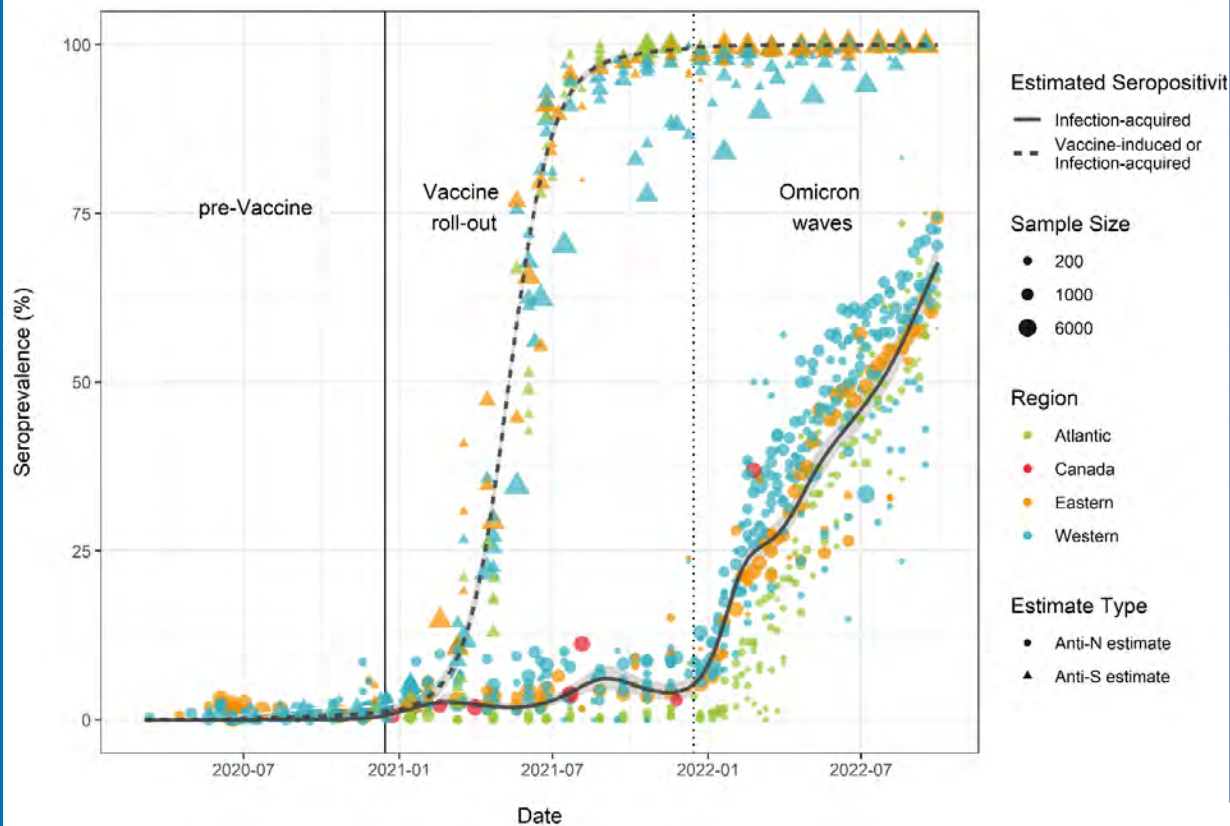
Infection-acquired seropositivity, by age:

Vaccine effectiveness during the Omicron period

- 45 days after receipt of the dose, VE = 44.9% (95% CI, 35.3 to 53.0)
- 90 days after receipt of the dose, VE=16.9% (95% CI, 2.7 to 28.9)
- Patterns similar in the dose-specific model and across age groups
- VE comparable between vaccine products (up to four months after vaccination):

  49.5% for the monovalent Moderna vaccine

  45.8% for the monovalent Pfizer-BioNTech vaccine

  similar in monovalent and bivalent booster recipients

Omicron period
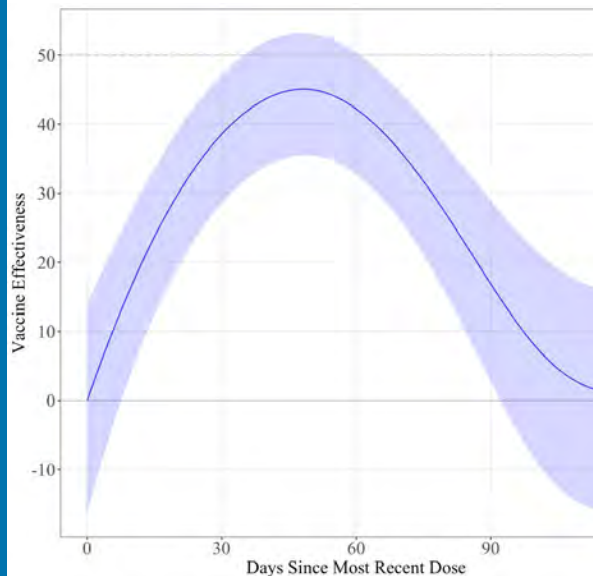
By dose number
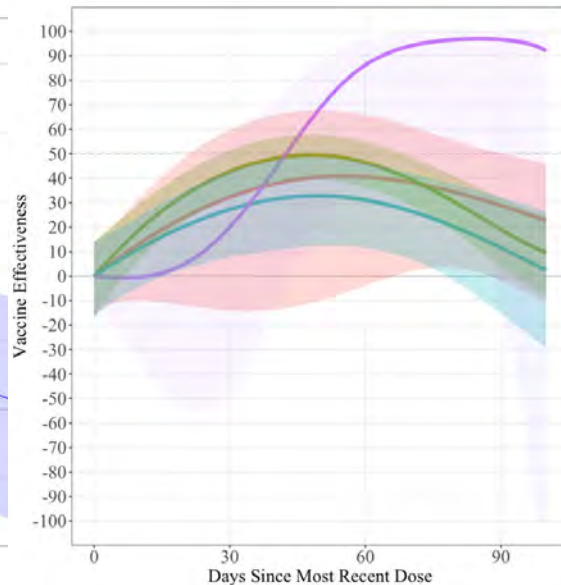
Bivalent vs. monovalent
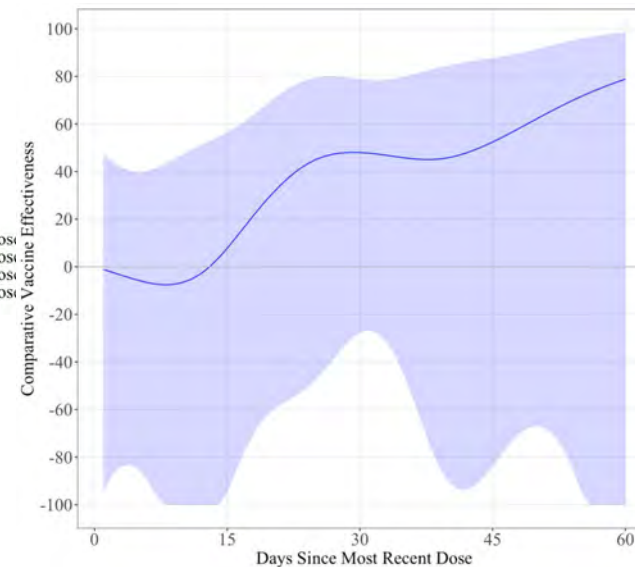
By age group
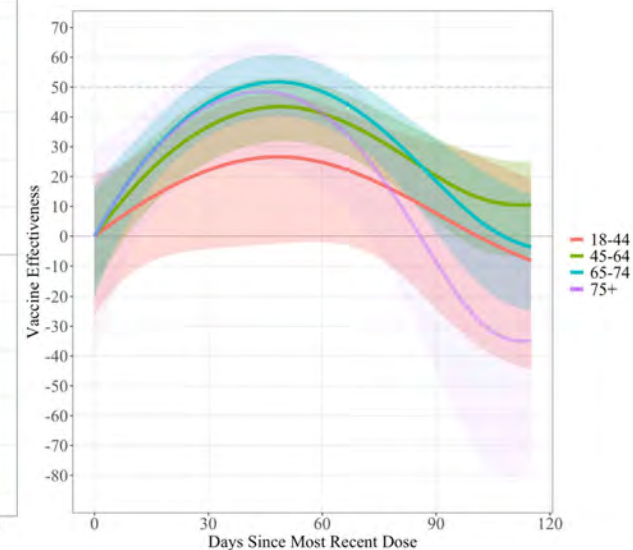
What's next?

- **Research community engagement**

- **More blood collection**

- **Sequence remainder of participants**

- **Ancillary Studies (chronic fatigue study, Canadian Alliance for Healthy Hearts and Minds)**

- **Second Health Status Follow-Up Questionnaire**

- **Diet and Physical Activity Questionnaire**

Linkage with CIHI data

Linkages between the CanPath cohort and the Canadian Institute for Health Information (CIHI) administrative health data are underway.

Individual-level linked CIHI data (N=290,000) will be hosted alongside the harmonized national CanPath dataset and made available to approved researchers requesting administrative health data along with cohort data and/or samples.
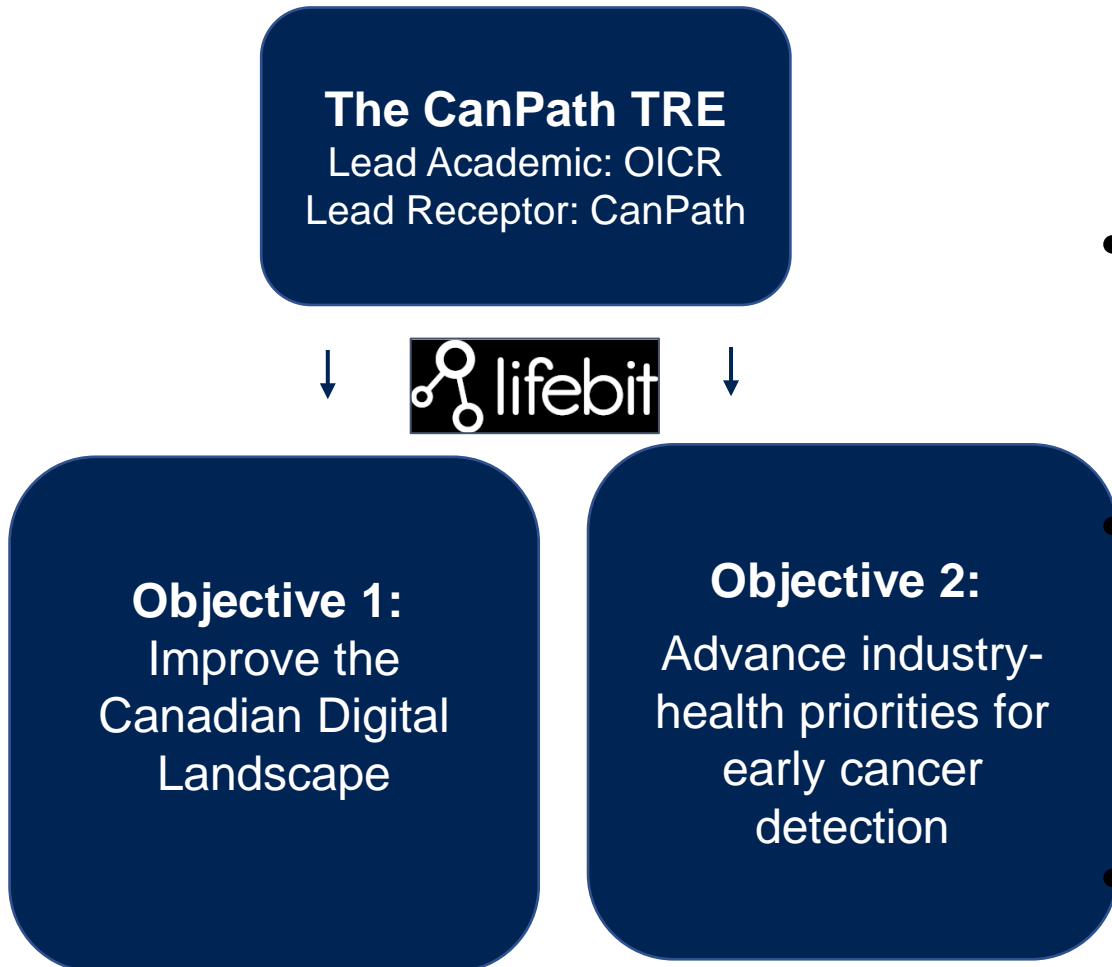
CanPath will be the first Canadian program to be able to combine the wealth of cohort resources with national administrative level data in a central location.

Canadian Institute
for Health Information
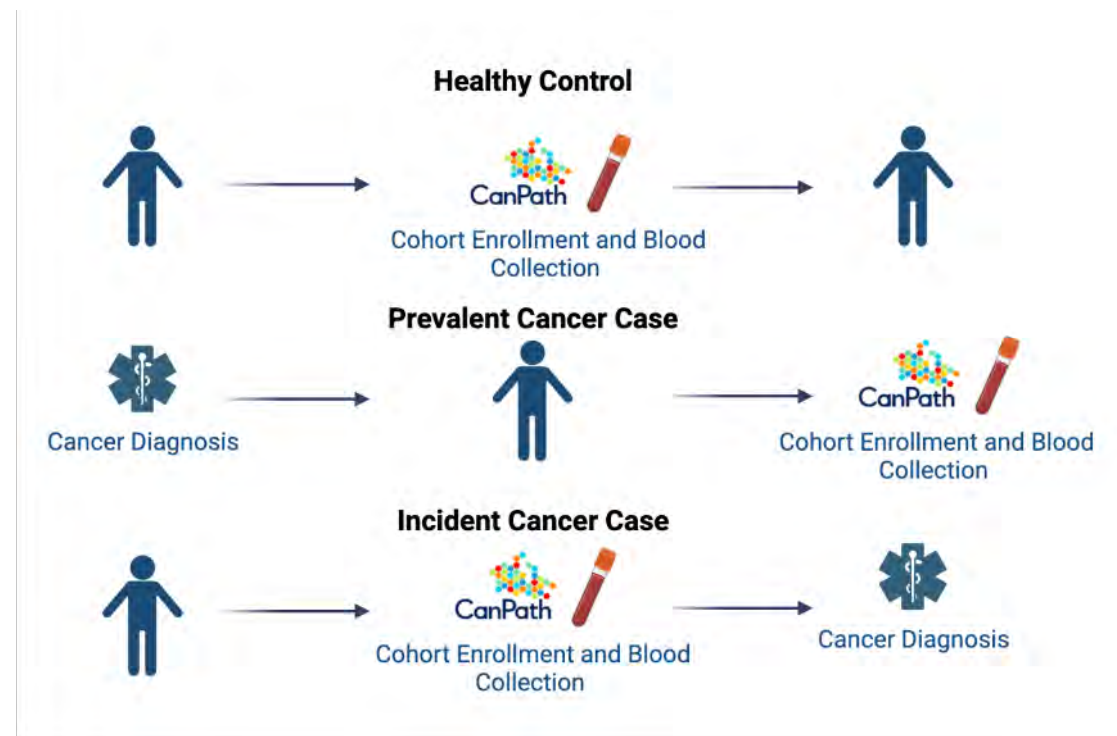
Institut canadien
d'information sur la santé

Development of a Trusted Research Environment (TRE)

The CanPath TRE
Lead Academic: OICR
Lead Receptor: CanPath

lifebit

Objective 1:
Improve the Canadian Digital Landscape

Objective 2:
Advance industry-health priorities for early cancer detection

- The Trusted Research Environment (TRE) will be a **data platform for Canadian researchers to access, analyze, and contribute to research in a collaborative environment**.

- The platform will **set an industry precedent** for collaborative data access and innovation, advancing Canada's global impact in population health research.

- Through development of the platform, **CanPath will be established as the Canadian leader in data governance for genetic and health information research**

- Adopting a TRE model will pave the way for **industry-utilisation of the CanPath resource**

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Building the Canadian Cancer Study

- CanPath is building the Canadian Cancer Study to advance research and discovery

- With linked clinical information, we can identify which participants joined the cohort **before developing disease**

- Using samples collected before disease onset, we are able to develop **novel approaches to detect disease years before current methods**

- We are adopting a three-pronged approach to **build the data resources required to enable early cancer prevention and detection research:**
    - Linking to national administrative data holdings
    - Harmonizing aggregate cancer data reporting nationally
    - Hosting linked individual-level cancer outcomes

Building the Canadian Cancer Study

Total number of cancers = 40,849
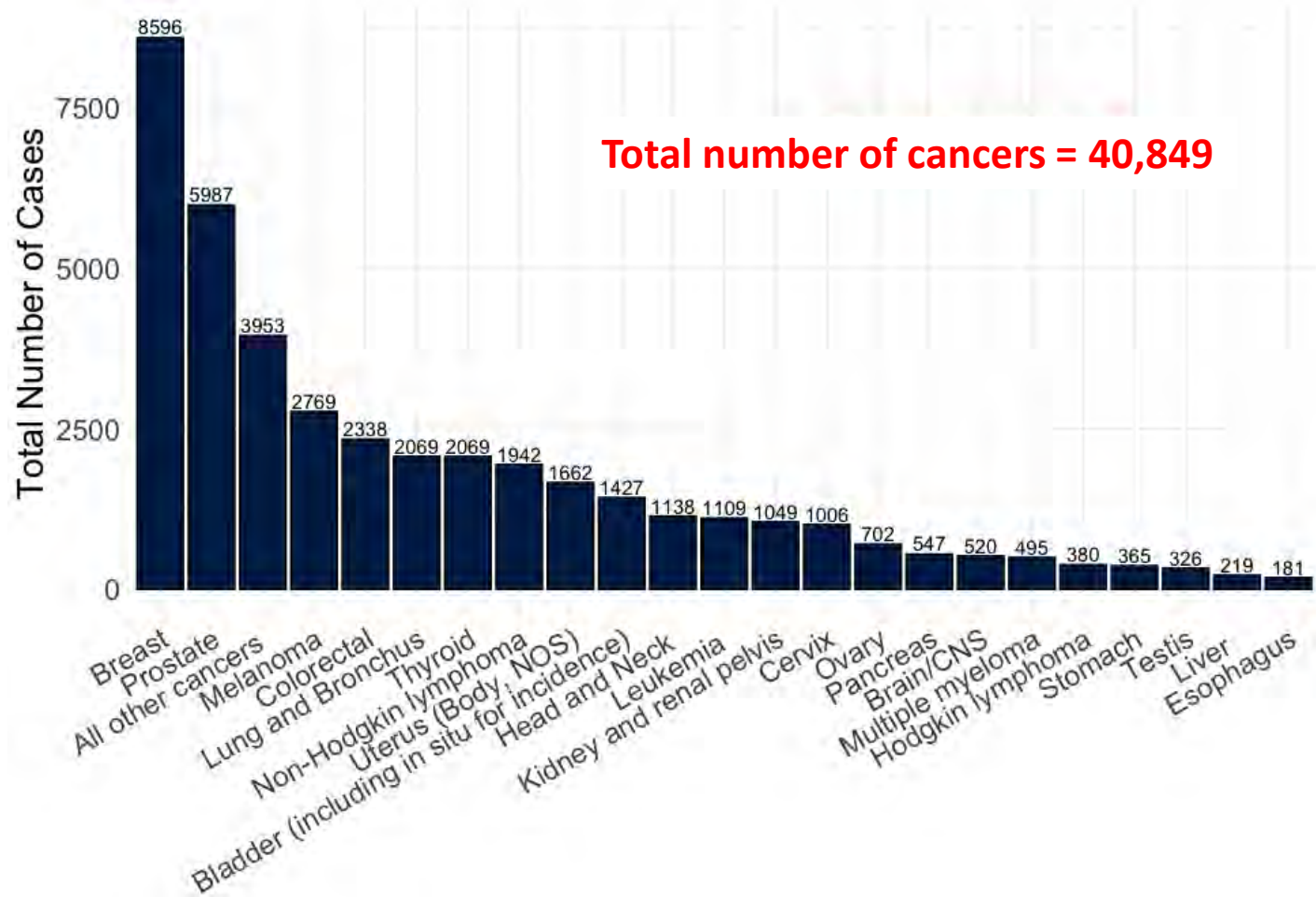
CanPath is leveraging provincial linkages to map cancer data and biosample holdings

All cancer data is collected and grouped according to Canadian Cancer Statistic guidelines

Regions included:
- Atlantic PATH
- Alberta for Tomorrow Project
- Ontario Health Study
- BC Generations Project

How to access OHS data and biospecimens

OHS Data Access Process

1. Submit Preliminary Access Application Form, if needed.

2. Secure funding.

3. Submit Data and Biosample Application Form and required documents.*

4. Data Access Committee reviews applications.

5. The OHS notifies the approved user and an Access Agreement is signed.

*Approval letter from Research Ethics Board (REB) *and* REB-approved research protocol; Evidence of scientific peer-review of research protocol, if available; 2-page CV of Principal Applicant; List of required data linkage to data repositories, if any.

Researchers can now apply for access to de-identified OHS data & biospecimens. Please contact **access@ontariohealthstudy.ca** for more information.

https://www.ontariohealthstudy.ca/for-researchers/data-access-process/

The OHS Team

The OHS is made possible through:

Funders

Participants

The OHS thanks all its participants for generously donating their time, energy and data to make this research possible.

Learn more about the Study

Read the OHS cohort profile paper in the **International Journal of Epidemiology** (Volume 52, Issue 2, April 2023)

Visit the OHS website at **www.OntarioHealthStudy.ca**

Contact the OHS Access Officer at **access@ontariohealthstudy.ca**

Ontario Health Study
Étude sur la santé Ontario