Public Health Ontario | Santé publique Ontario

COVID-19 Serosurveillance Summary

COVID-19 Seroprevalence in Ontario: March 27, 2020 to June 30, 2020

Purpose

Public Health Ontario (PHO) has initiated a Coronavirus Disease 2019 (COVID-19) serosurveillance program. This program aims to estimate the proportion of the Ontario population that has been infected by and developed antibodies against SARS-CoV-2, the virus that causes COVID-19, at various points in time by age group, sex and Ontario region. This is done through serology testing (a laboratory test that measures antibodies specific to COVID-19). Serological tests can be used to determine the proportion of the population that has been infected with COVID-19; however, they cannot determine current infection or infectivity. Furthermore, at this time the correlation between a positive antibody test and immunity to COVID-19 is unknown. The results of this work will allow us to understand which groups and subgroups in the Ontario population have been infected with COVID-19, and to enhance pandemic prevention and preparedness efforts.

For our serosurveys, we tested blood specimens that were submitted to the PHO Laboratory for other purposes. The specimens are de-identified before testing for COVID-19 antibodies, protecting the identity of the individuals.

We performed three cross-sectional surveys during the periods of March 27 – April 30, May 26 – 31 and June 5 – 30, 2020. The March – April and May serosurveys utilized a smaller number of specimens (N=827 and N=1,061, respectively) than the June serosurvey (N=7,014), and therefore for these surveys we have only presented seroprevalence results overall and by broad age groups. For the June survey, the larger sample size allowed for a more detailed analysis. In subsequent serosurveys we plan to test larger sample sizes to allow for more detailed analyses.

Highlights

- Of tested specimens submitted to the PHO Laboratory between March 27 – April 30, 2020, 3/827 (0.4%) were positive for COVID-19 antibodies. When adjusted for population weighting and serology test characteristics, seroprevalence was 0.5% (95% CI 0.1, 1.5).
- Of tested specimens submitted to the PHO Laboratory between May 26 – 31, 2020, 15/1,061 (1.4%) were positive for COVID-19 antibodies. Adjusted seroprevalence was 1.5% (95% CI 0.7, 2.2).
- Of tested specimens submitted to the PHO Laboratory between June 5 – 30, 2020, 79/7,014 (1.1%) were positive for COVID-19 antibodies. Adjusted seroprevalence 1.1% (95% CI 0.8, 1.3).

- In the June serosurvey, the proportion of positive samples varied by age group and ranged from 0/87 (0.0%) in individuals age 5-9 years to 13/518 (2.5%) in individuals age ≥80 years. Adjusted seroprevalence ranged from 0.0% (95% CI 0.0, 4.6) in individuals age 5-9 years to 2.6% (95% CI 1.2, 4.0) for individuals age ≥80 years.

- The proportion of positive samples varied by sex, and was 45/3,423 (1.3%) in males and 34/3,591 (0.9%) in females. Adjusted seroprevalence was 1.2% (95% CI, 0.9, 1.6) in males and 1.0% (95% CI 0.7, 1.3) in females. Females had a higher seroprevalence than males in individuals aged 0-19 years, while males had higher seroprevalence than females in individuals aged 20-59 years and ≥60 years.

- The proportion of positive samples varied greatly by geographic region. The adjusted seroprevalence ranged from 0.3% (95% CI 0.04, 1.1) and 0.3% (95% CI 0.009, 1.9) in the Eastern and Northern regions, respectively, to 1.5% (95% CI 1.0, 2.0) and 1.5% (95% CI 0.9, 2.1) in Central East and Toronto, respectively.

Methods

The Ontario COVID-19 Serosurveillance System uses residual specimens (blood, serum or plasma left over after diagnostic testing) to test for antibodies against COVID-19 infection. These specimens initially underwent diagnostic testing at the PHO Laboratory for various purposes, but not specifically for COVID-19. Specimens were proportionately selected based on the distribution of age groups (as per the World Health Organization's Unity Studies Population-based age-stratified sero-epidemiological investigation protocol for COVID-19 infection, version 2.0), sex and residence in each health region of Ontario, but were not wholly representative of Ontario due to a lack of available specimens in some age and geographical groups. Specimens were de-identified prior to testing.

To obtain seroprevalence estimates, we first tested the specimens for COVID-19 antibodies using an orthogonal testing approach (see the Data Sources and Laboratory Testing section), calculating the proportion of specimens that were positive for COVID-19 antibodies overall, by age group, sex and geographical region. Since populations tested at the PHO Laboratory could be different from the general population, we then adjusted our estimates in order to account for differences between the sample and the population structure of Ontario, and test sensitivity and specificity. First, we developed and applied post-stratification weights derived from Ontario population projection data for 2020, which were sourced from Ontario Ministry of Health, IntelliHEALTH Ontario (extracted on November 26, 2019). Weighting was based on age group (0-19, 20-59, and 60+ years), sex, and region (Toronto, Central East and Central West versus Northern, Eastern, and South West) to extrapolate our results to the Ontario population. Next, we adjusted for test characteristics (i.e., 90.4% sensitivity, 100% specificity) in order to produce final adjusted seroprevalence estimates. Confidence intervals were calculated based on the Wald method when the numerator was 5 or more, and based on the Clopper-Pearson method when the numerator was less than 5.

Characteristics of Tested Specimens

Table 1: Characteristics of seroprevalence specimens submitted to the PHO Laboratory, March 27 - June 30, 2020

Characteristic	Collection period and number of specimens (%)	Collection period and number of specimens (%)	Collection period and number of specimens (%)
	March 27 – April 30, 2020, N = 827	May 26 – May 31, 2020, N = 1,061	June 5 – June 30, 2020, N = 7,014
Sex: Male	337 (40.7)	525 (49.5)	3,423 (48.8)
Sex: Female	490 (59.3)	536 (50.5)	3,591 (51.2)
Age group: 0-19 years	182 (22.0)	218 (20.5)	978 (13.9)
Age group: 20-59 years	503 (60.8)	521 (49.1)	3,996 (57.0)
Age group: ≥60 years	142 (17.2)	322 (30.3)	2,040 (29.1)
Region: Northern	238 (28.8)	74 (7.0)	422 (6.0)
Region: Eastern	47 (5.7)	29 (2.7)	627 (8.9)
Region: Central East	205 (24.8)	399 (37.6)	2,446 (34.9)
Region: Toronto	259 (31.3)	275 (25.9)	1,837 (26.2)
Region: South West	30 (3.6)	93 (8.8)	446 (6.4)
Region: Central West	48 (5.8)	191 (18.0)	1,236 (17.6)

Note: Age group was assigned based on age of the individual when their specimen was received at PHO Laboratory, and sex was as recorded on the laboratory requisition. Health region was determined using the individual's health region of residence, or the submitter's health region when this information was missing. The adjusted seroprevalence was determined by adjusting for population weighting and test characteristics.

Seroprevalence over time

We collected specimens received at the PHO Laboratory during three time periods: March 27 – April 30, 2020; May 26 – 31, 2020; and June 5 – 30, 2020. A total of 827 serology specimens received between March 27 – April 30, 2020 were tested for COVID-19 antibodies; 1,061 were tested from specimens received between May 26 – 31, 2020; and 7,014 were tested from specimens received between June 5 – 30, 2020.

Our sampling strategy for the March – April and May surveys varied from the strategy used for the June 5 – 30, 2020 serosurvey, therefore comparisons between estimates should be made with caution. For the March – April serosurvey, we used broader age groups and regional criteria when selecting specimens due to less availability of clinical specimens. In May, our collection period spanned only six days. During both time periods, Ontarians had restricted access to healthcare due to the COVID-19 pandemic, which may introduce bias for these two collection periods compared to the June collection period, when restrictions were starting to lift.

- Of tested specimens submitted to PHO Laboratory between March 27 – April 30, 2020, 3/827 (0.4%) were positive for COVID-19 antibodies. When adjusted for population weighting and serology test characteristics, seroprevalence was 0.5% (95% CI 0.1, 1.5).
- Of tested specimens submitted to PHO Laboratory between May 26 – 31, 2020, 15/1,061 (1.4%) were positive for COVID-19 antibodies. Adjusted seroprevalence was 1.5% (95% CI 0.7, 2.2).
- Of tested specimens submitted to PHO Laboratory between June 5 – 30, 2020, 79/7,014 (1.1%) were positive for COVID-19 antibodies. Adjusted seroprevalence 1.1% (95% CI 0.8, 1.3).

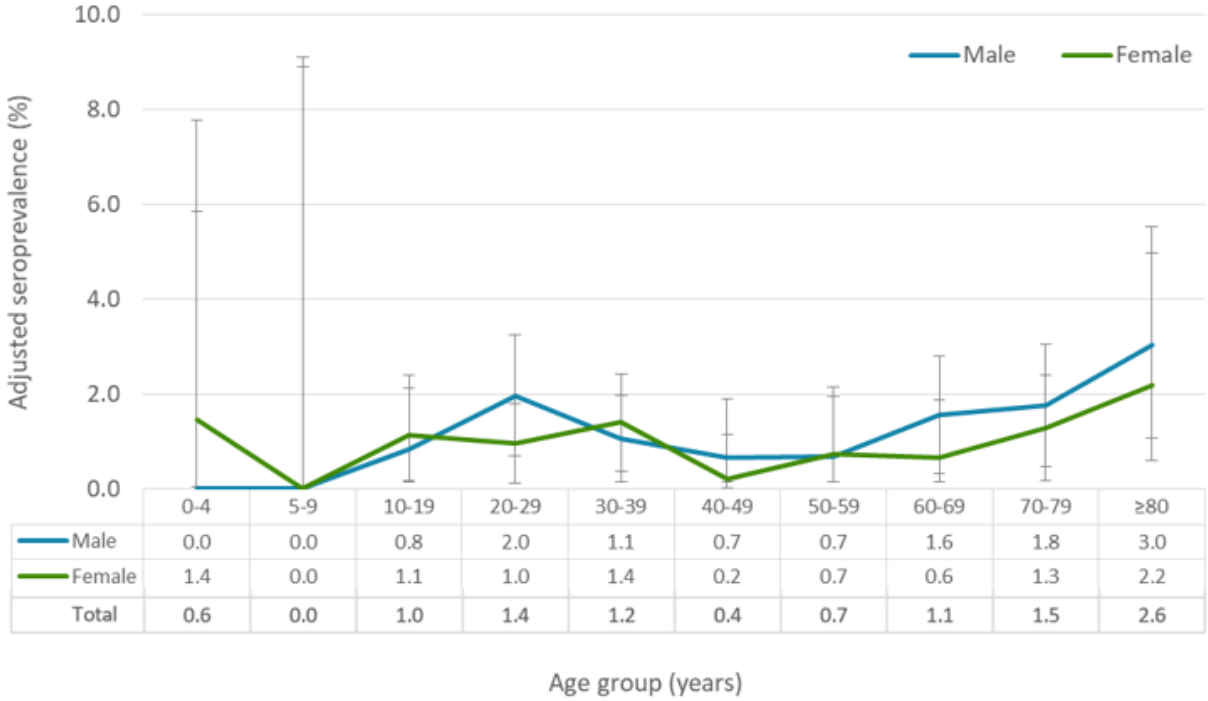
Seroprevalence by Age Group and Sex

Table 2. The proportion of positive specimens and adjusted COVID-19 seroprevalence by age group and sex, March 27 - June 30, 2020

Time Period and Age Group	Number of positive specimens n/N (%)			Adjusted seroprevalence (95% CI)		
	Males	Females	Total	Males	Females	Total
March – April 0-19 years	0/89 (0.0)	0/93 (0.0)	0/182 (0.0)	0.0% (0.0, 4.5)	0.0% (0.0, 4.3)	0.0% (0.0, 2.2)
March – April 20-59 years	1/169 (0.6)	0/334 (0.0)	1/503 (0.2)	0.8% (0.02, 4.2)	0.0% (0.0, 1.2)	0.4% (0.01, 2.1)
March – April ≥60 years	2/79 (2.5)	0/63 (0.0)	2/142 (1.4)	2.8% (0.3, 9.7)	0.0% (0.0, 6.3)	1.3% (0.2, 4.6)
May 0-19 years	0/91 (0.0)	2/127 (1.6)	2/218 (0.9)	0.0% (0.0, 4.4)	1.4% (0.2, 4.8)	0.7% (0.1, 2.4)
May 20-59 years	4/274 (1.5)	6/247 (2.4)	10/521 (1.9)	1.6% (0.4, 4.1)	2.6% (0.6, 4.7)	2.1% (0.8, 3.4)
May ≥60 years	2/160 (1.3)	1/162 (0.6)	3/322 (0.9)	1.1% (0.1, 4.0)	0.5% (0.01, 2.9)	0.8% (0.2, 2.4)
June 0-19 years	3/452 (0.7)	6/526 (1.1)	9/978 (0.9)	0.6% (0.1, 1.8)	1.1% (0.2, 1.9)	0.8% (0.3, 1.4)
June 20-59 years	20/1,917 (1.0)	16/2,079 (0.8)	36/3,996 (0.9)	1.1% (0.6, 1.6)	0.8% (0.4, 1.2)	1.0% (0.7, 1.3)
June ≥60 years	22/1,054 (2.1)	12/986 (1.2)	34/2,040 (1.7)	2.0% (1.2, 2.8)	1.2% (0.5, 1.9)	1.6% (1.1, 2.1)

Note: N represents the number of specimens tested, while n is the number of positive specimens. Adjusted seroprevalence was calculated as the number of positive specimens divided by the total number of specimens tested during that time period, multiplied by 100, and adjusted for population weighting and test characteristics.

Figure 1. Adjusted COVID-19 seroprevalence by age group and sex, June 5 – 30, 2020

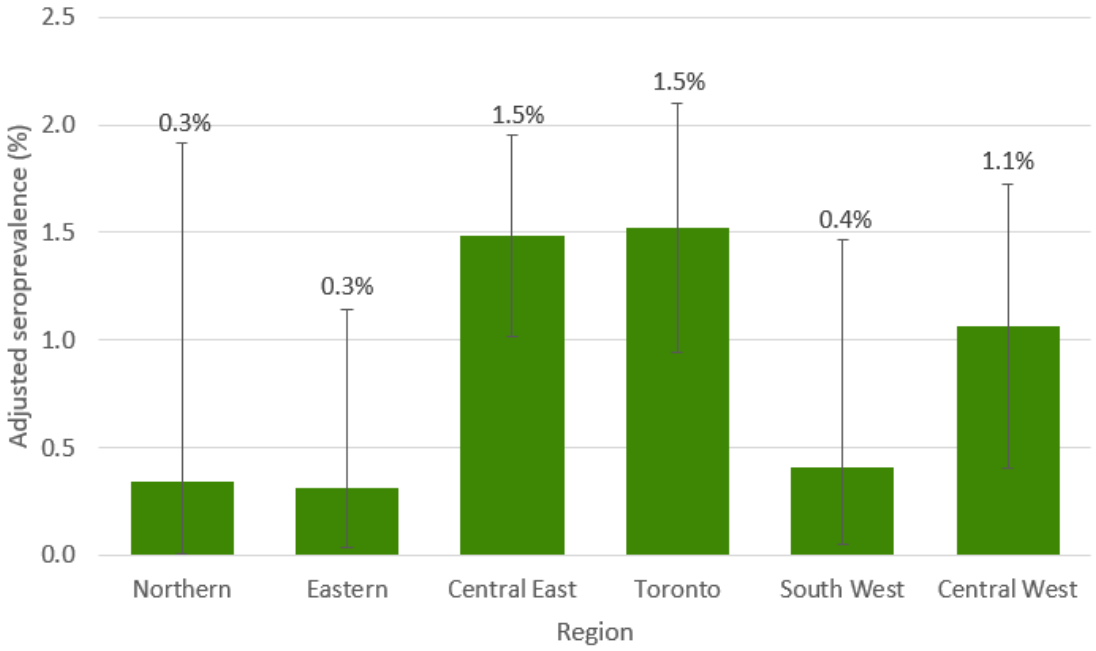


	0-4	5-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	≥80
Male	0.0	0.0	0.8	2.0	1.1	0.7	0.7	1.6	1.8	3.0
Female	1.4	0.0	1.1	1.0	1.4	0.2	0.7	0.6	1.3	2.2
Total	0.6	0.0	1.0	1.4	1.2	0.4	0.7	1.1	1.5	2.6

Note: Adjusted seroprevalence was calculated as the number of positive specimens divided by the total number of specimens tested during that time period, multiplied by 100, and adjusted for population weighting and test characteristics. Error bars represent the 95% CI.

Seroprevalence by Geographical Region

Figure 2. Adjusted COVID-19 seroprevalence by Ontario region, June 5, 2020 to June 30, 2020



Note: Health region was determined using the individual's health region of residence, or the submitter's health region when this information was missing. Adjusted seroprevalence was calculated as the number of positive specimens divided by the total number of specimens tested during that time period, multiplied by 100, and adjusted for population weighting and test characteristics. Error bars represent the 95% CI.

Technical Notes and Data Caveats

Data Sources and Laboratory Testing

Specimens tested to generate seroprevalence estimates were originally submitted to PHO Laboratory for clinical testing for antibodies to a variety of infectious diseases (but not COVID-19).Testing for antibodies against COVID-19 was performed at the Toronto site of the PHO Laboratory. Two testing methods were used: the primary test was the Abbott Architect SARS-CoV-2 IgG assay (chemiluminescent microparticle immunoassay (CMIA)). This was followed by a supplemental test using the Ortho-Diagnostics VITROS anti-SARS-CoV-2 IgG assay (chemiluminscent immunoassay (CLIA)). Both assays are intended for the qualitative detection of IgG antibodies to SARS-CoV-2 in human serum. Specimens were initially tested using the Abbott Architect SARS-CoV-2 IgG assay. Specimens that were reactive (i.e., positive) were then tested using the VITROS anti-SARS-CoV-2 IgG assay. In the case of inconsistent results between the two tests, the VITROS anti-SARS-CoV-2 IgG assay result was considered the final result. This orthogonal testing approach substantially increases the positive predictive value of the laboratory result (which is low when using only one assay when population prevalence is low) and decreases the number of false positive results. In PHO Laboratory's assay evaluation, the combined sensitivity and specificity in specimens collected >14 days after symptom onset (or from date of collection if symptom onset date was not provided) when using the orthogonal testing was 90.4% and 100%, respectively.

Ontario regions were grouped as follows:

- Toronto: Toronto Public Health
- Central East: Durham Region Health Department, Haliburton, Kawartha, Pine Ridge District Health Unit, Peel Public Health, Peterborough Public Health, Simcoe Muskoka District Health Unit, and York Region Public Health
- Central West: Brant County Health Unit, City of Hamilton Public Health Services, Haldimand-Norfolk Health Unit, Halton Region Public Health, Niagara Region Public Health, Region of Waterloo Public Health and Emergency Services, and Wellington-Dufferin-Guelph Public Health
- Eastern: Ottawa Public Health, Eastern Ontario Health Unit, Hastings Prince Edward Public Health, Kingston, Frontenac and Lennox & Addington Public Health, Leeds, Grenville & Lanark District Health Unit, and Renfrew County and District Health Unit
- Northern: Northwestern Health Unit, Thunder Bay District Health Unit, Algoma Public Health, North Bay Parry Sound District Health Unit, Porcupine Health Unit, Public Health Sudbury & Districts, and Timiskaming Health Unit
- South West: Chatham-Kent Public Health, Grey Bruce Health Unit, Huron Perth Public Health, Lambton Public Health, Middlesex-London Health Unit, Southwestern Public Health, and Windsor-Essex County Health Unit

Counts reported throughout the summary are specimen-based and not person-based. As such, it is possible that more than one specimen was tested per individual. We excluded specimens with missing information on age group, sex or geographical region of residence. Specimens without sufficient quantity or those where the specimen quality was compromised were also excluded.

The specimen types used in each selection period varied slightly. During the May and the June selection periods, both blood and serum specimens were included, whereas in March – April only serum specimens were included.

It should be noted that false positive COVID-19 serology results are possible due to cross-reaction with pre-existing antibodies against other human coronaviruses, including SARS-CoV-1 and certain seasonal coronaviruses (e.g. human coronavirus OC43). Although we assumed that our testing was 100% specific as per the results of our laboratory validation, specificity may be lower. A negative test result does not rule out current or previous COVID-19 infection, because it takes at least 7-14 days to produce a measurable antibody response, and some individuals do not produce a sufficient antibody response at all. Furthermore, specimens from individuals who are immunocompromised or are too young to produce an adaptive immune response may also produce false negative results.

Data used for this report are from the Laboratory Information Management System at PHO Laboratory. The information is current as of July 14, 2020.

Funding

Serology tests for the PHO Serosurveillance Initiative were kindly provided by the COVID-19 Immunity Task Force.

Disclaimer

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Citation

Ontario Agency for Health Protection and Promotion (Public Health Ontario). COVID-19 Serosurveillance Summary - Seroprevalence in Ontario: March 27, 2020 to June 30, 2020. Toronto, ON: Queen's Printer for Ontario; 2020.

For Further Information

For more information, email cd@oahpp.ca.

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