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COVID-19 Serosurveillance Summary

(ARCHIVED) COVID-19 Seroprevalence in Ontario: September 3 to October 30, 2020

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Purpose

The Public Health Ontario (PHO) Coronavirus Disease 2019 (COVID-19) serosurveillance 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 at a point in time; however, they cannot determine current infection or infectivity. Furthermore, the correlation between a positive antibody test and immunity to SARS-CoV-2 is currently 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 over time, and to enhance pandemic prevention and preparedness efforts.

For our serosurveys, we tested blood specimens that were submitted to PHO's laboratory for other purposes. The specimens are de-identified before testing for COVID-19 antibodies, protecting the identity of the individuals. In this report, we present results for September and October, 2020.

Highlights

- Of specimens submitted to PHO's laboratory between September 3 – 30, 2020, 35/4,901 (0.7%) were positive for COVID-19 antibodies. When adjusted for sample representativeness and serology test characteristics, overall seroprevalence was 0.7% (95% Confidence interval (CI) 0.4, 0.9). Of specimens submitted to PHO between October 1 – 30, 2020, 79/7,107 (1.1%) were positive for COVID-19 antibodies. When adjusted for sample representativeness and serology test characteristics, seroprevalence was 1.2% (95% CI 0.9, 1.4).

- Adjusted seroprevalence varied by age group. In September, it ranged from 0.0% (95% CI 0.0, 3.7) and 0.0% (95% CI 0.0, 2.6) in individuals age 0-9 and ≥80 years, respectively, to 1.0% (95% CI 0.4, 1.7) and 1.0% (95% CI 0.5, 1.6) for individuals age 20-29 years and 30-39 years, respectively. In October, it ranged from 0.7% (95% CI 0.02, 4.1) and 0.7% (95% CI 0.09, 1.3) in individuals age 0-9 and 70-79, respectively, to 1.7% (95% CI 0.9, 2.6) in individuals age 50-59 years.

- Adjusted seroprevalence varied by sex. In September it was 0.8% (95% CI 0.4, 1.1) and 0.6% (95% CI, 0.3, 0.8) in males and females, respectively. In October it was 1.0% (95% CI 0.6, 1.3) and 1.4% (95% CI 1.0, 1.8) in males and females, respectively.

- Adjusted seroprevalence varied greatly by geographic region during both months. The lowest estimates were in Northern Ontario, at 0.1% (95% CI 0.003, 0.6) and 0.2% (95% CI 0.005, 1.1) in September and October, respectively. The highest estimates were in Toronto and Central East Ontario, at 0.9% (95% CI 0.3, 1.5) and 0.9% (95% CI 0.5, 1.4), respectively, in September and 2.0% (95% CI 1.3, 2.7) and 1.3% (95% CI 0.8, 1.8), respectively, in October.

- The adjusted seroprevalence estimates in September and October, 2020, were lower than expected considering the increasing COVID-19 incidence in Ontario during this time. This could be due to declining antibody levels in specimens from individuals who were infected with COVID-19 earlier in the pandemic. In addition, our current testing algorithm may not be sensitive enough to detect waning levels of antibodies in the population. At this time, we will be pausing the COVID-19 serosurveys as we continue to investigate COVID-19 antibody decline and to further evaluate our laboratory testing algorithm.

Methods

PHO's Ontario COVID-19 serosurveillance program 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 PHO Laboratory for various purposes, but not specifically for COVID-19. Subject to availability, specimens were proportionately selected based on the distribution of age groups (as per the World Health Organization's Unity Studies[1] Population-based age-stratified sero-epidemiological investigation protocol for COVID-19 infection, version 2.0), sex, and residence in each health region of Ontario. 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. Confidence intervals were calculated based on the Wald method when the numerator was five or more, and based on the Clopper-Pearson method when the numerator was less than five.

Since populations tested at PHO Laboratory could be different from the general population, we then adjusted the raw estimates 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). Strata were 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): weights for each stratum were equal to the population proportion divided by the sample proportion. Next, we adjusted for test characteristics (i.e., 90.4% sensitivity, 100% specificity) in order to produce final adjusted seroprevalence estimates.

Since COVID-19 incidence varies across Ontario neighbourhoods,[2] and over- or under-representation of specimens from individuals residing in neighbourhoods with high levels of identified COVID-19 cases could have led to reduced accuracy of our estimates, we performed a sensitivity analysis. This analysis incorporated the quintile of confirmed COVID-19 incidence of the forward sortation area as an additional poststratification variable. This ensured that the seroprevalence estimates were representative of Ontario residents from neighbourhoods with both low and high levels of identified COVID-19 infection.

Characteristics of Tested Specimens

Table 1: Characteristics of specimens submitted to PHO's laboratory from September 3 to October 30, 2020 and characteristics of the Ontario population

Characteristic	Number of specimens (%), September 3 – September 30, 2020 N = 4,901	Number of specimens (%), October 1 – October 30, 2020 N = 7,107	Distribution in the Ontario population %
Sex: Male	2,114 (43.1)	3,509 (49.4)	49.2%
Sex: Female	2,787 (56.9)	3,598 (50.6)	50.8%
Age group: 0-19 years	488 (10.0)	971 (13.7)	21.1%
Age group: 20-59 years	3,640 (74.3)	4,000 (56.3)	54.5%
Age group: ≥60 years	773 (15.8)	2,136 (30.1)	24.4%
Region: Northern	472 (9.6)	389 (5.5)	5.4%
Region: Eastern	364 (7.4)	539 (7.6)	13.0%
Region: Central East	1,624 (33.1)	2,361 (33.2)	30.1%
Region: Toronto	1,207 (24.6)	1,779 (25.0)	21.0%
Region: South West	428 (8.7)	708 (10.0)	11.4%
Region: Central West	806 (16.4)	1,331 (18.7)	19.2%

Note: Age group was assigned based on age of the individual when their specimen was received at PHO's 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. Distribution of the Ontario population by age, sex, and region was sourced from the Ontario Ministry of Health, IntelliHEALTH Ontario (extracted on November 26, 2019).

Seroprevalence by Age Group and Sex

Table 2a. The proportion of positive specimens (% (n/N) (95% CI)) by age group and sex, September 3 to September 30, 2020

Age Group	Males	Females	Total
0-19 years	0.5% (1/200)	0.3% (1/288)	0.4% (2/488)
20-59 years	0.7% (10/1,492)	0.8% (18/2,148)	0.8% (28/3,640)
≥60 years	1.2% (5/422)	0% (0/351)	0.6% (5/773)

Table 2b. The adjusted COVID-19 seroprevalence (% (95% CI)) by age group and sex, September 3 to September 30, 2020

Age Group	Males	Females	Total
0-19 years	0.5 % (0.01, 2.7)	0.4% (0.009, 2.0)	0.4% (0.05, 1.5)
20-59 years	0.7 % (0.3, 1.2)	0.9% (0.5, 1.4)	0.8% (0.5, 1.1)
≥60 years	1.1 % (0.1, 2.0)	0.0% (0.0, 1.2)	0.5% (0.06, 0.9)

Table 3a. The proportion of positive specimens (% (n/N) (95% CI)) by age group and sex, October 1 to October 30, 2020

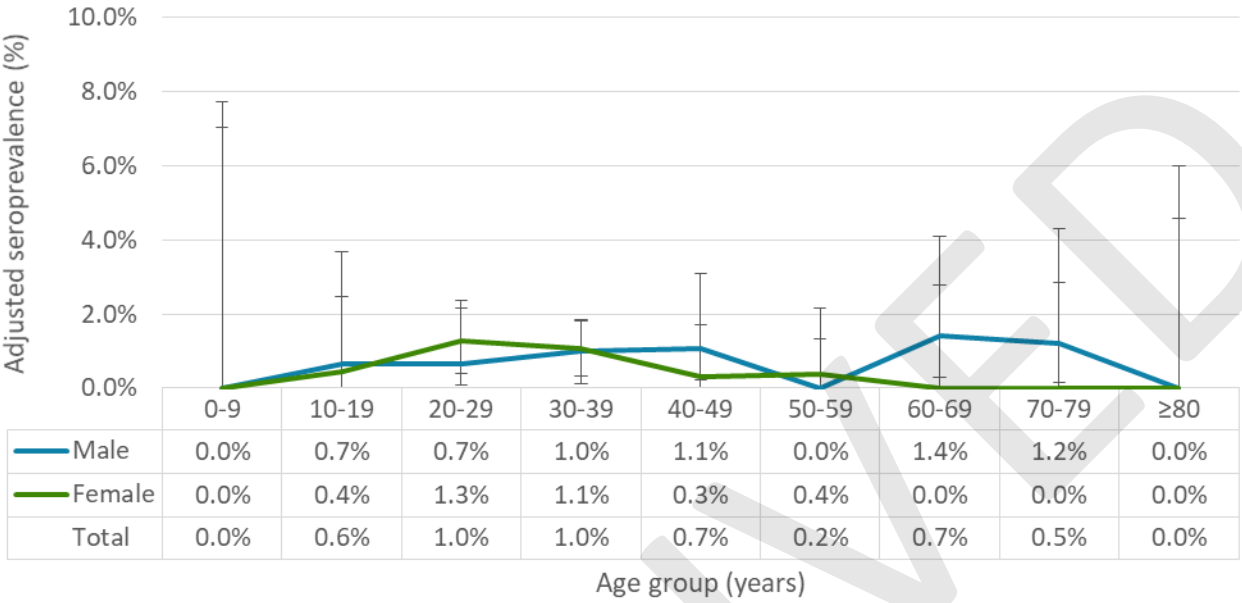
Age Group	Males	Females	Total
0-19 years	0.9% (4/452)	1.3% (7/519)	1.1% (11/971)
20-59 years	1.0% (19/1,965)	1.4% (28/2,035)	1.2% (47/4,000)
≥60 years	0.8% (9/1,092)	1.1% (12/1,044)	1.0% (21/2,136)

Table 3b. The adjusted COVID-19 seroprevalence (% (95% CI)) by age group and sex, October 1 to October 30, 2020

Age Group	Males	Females	Total
0-19 years	1.0% (0.3, 2.7)	1.4% (0.4, 2.4)	1.2% (0.5, 1.9)
20-59 years	1.0% (0.6, 1.5)	1.5% (1.0, 2.1)	1.3% (0.9, 1.7)
≥60 years	0.7% (0.2, 1.2)	1.1% (0.5, 1.8)	0.9% (0.5, 1.3)

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

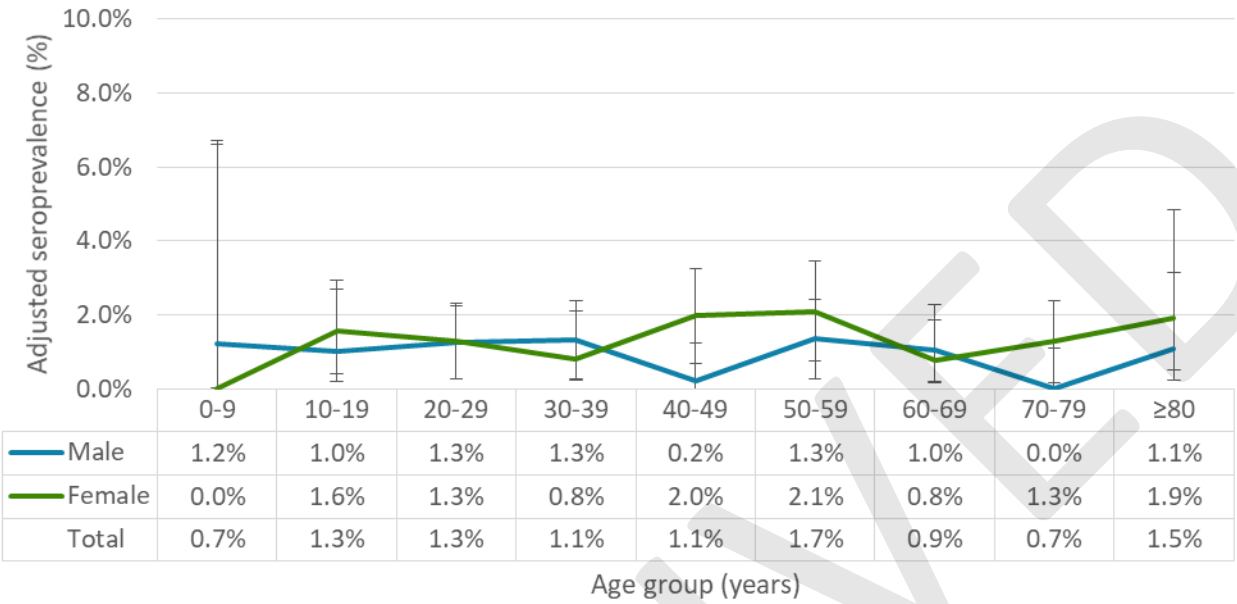
Figure 1. Adjusted COVID-19 seroprevalence by age group and sex, September 3 to September 30, 2020



	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	≥80
Male	0.0%	0.7%	0.7%	1.0%	1.1%	0.0%	1.4%	1.2%	0.0%
Female	0.0%	0.4%	1.3%	1.1%	0.3%	0.4%	0.0%	0.0%	0.0%
Total	0.0%	0.6%	1.0%	1.0%	0.7%	0.2%	0.7%	0.5%	0.0%

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.

Figure 2. Adjusted COVID-19 seroprevalence by age group and sex, October 1 to October 30, 2020

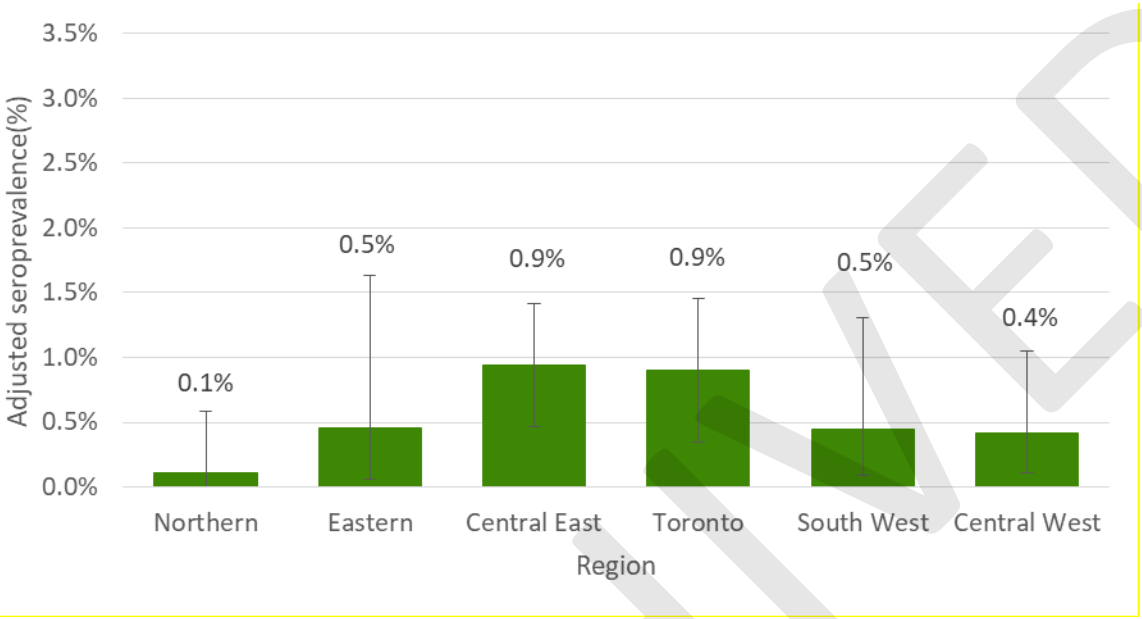


	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	≥80
Male	1.2%	1.0%	1.3%	1.3%	0.2%	1.3%	1.0%	0.0%	1.1%
Female	0.0%	1.6%	1.3%	0.8%	2.0%	2.1%	0.8%	1.3%	1.9%
Total	0.7%	1.3%	1.3%	1.1%	1.1%	1.7%	0.9%	0.7%	1.5%

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.

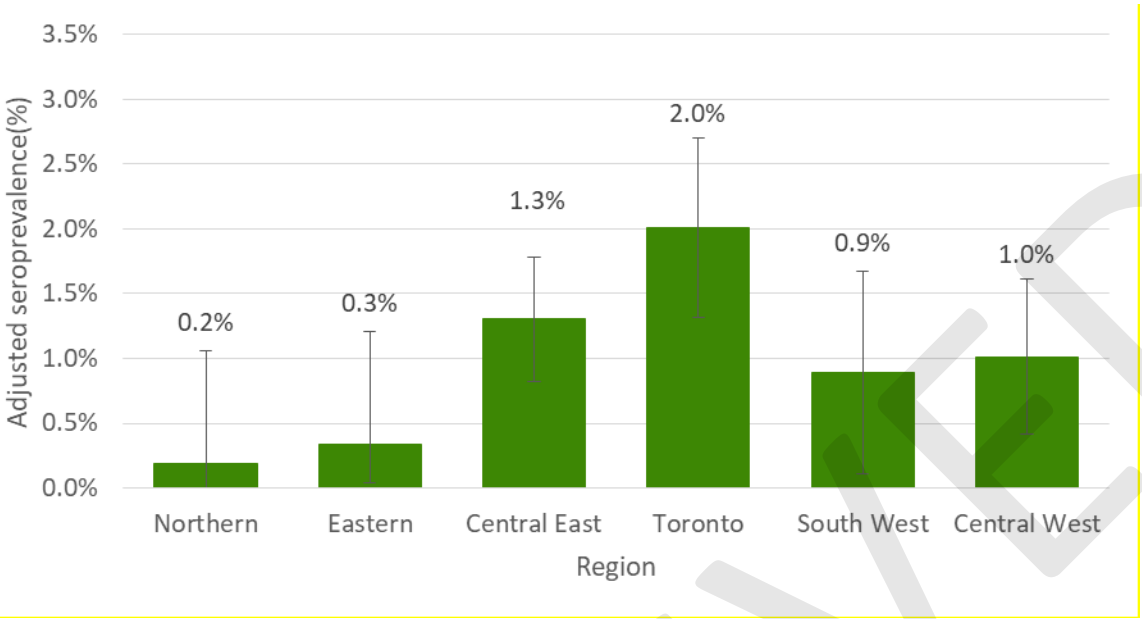
Seroprevalence by Geographical Region

Figure 3. Adjusted COVID-19 seroprevalence by Ontario region, September 3 to September 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.

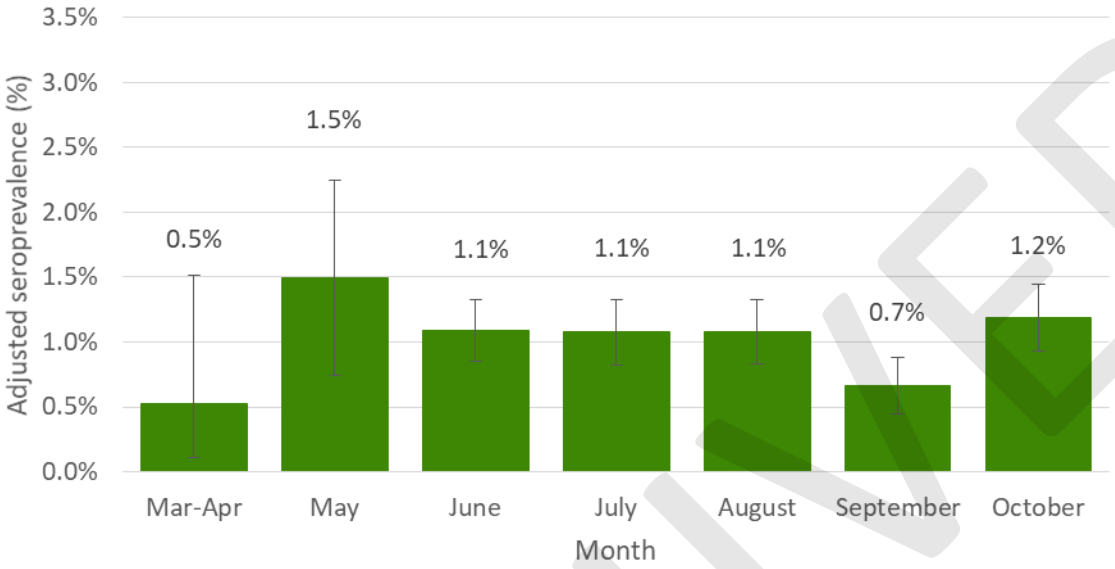
Figure 4. Adjusted COVID-19 seroprevalence by Ontario region, October 1 to October 30, 2020



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.

Seroprevalence over Time

Figure 5. Adjusted COVID-19 seroprevalence by month, March to October, 2020



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.

Interpretation

- The adjusted seroprevalence estimates for September and October, at 0.7% and 1.2%, respectively, were lower than expected considering the increase in COVID-19 incidence in Ontario during this time.
- These lower than expected adjusted seroprevalence estimates could be related to declining levels of COVID-19 antibodies in specimens representing individuals infected several months previously. In analyses not presented here, we noted a decrease in the geometric mean titre[3] (the average antibody concentration) of antibody-positive specimens collected during the summer months, compared to antibody positive specimens from earlier in the pandemic.
    - Although antibody decline would affect the sensitivity of any COVID-19 serology test, there is evidence that some assays (including some of those used in the PHO testing algorithm) are less sensitive than others for detecting antibodies at longer time points after infection[4].
- At this time, we will be pausing our monthly COVID-19 serosurveys as we continue to investigate COVID-19 antibody decline and further evaluate our laboratory testing algorithm.

Technical Notes and Data Caveats

Data Sources and Laboratory Testing

Specimens tested to generate seroprevalence estimates were originally submitted to PHO 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 PHO's 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'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.

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 when testing specimens from the general population. 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 waning may occur months after infection. In addition, 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. The information is current as of November 11, 2020.

References

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Disclaimer

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For Further Information

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