

Health Reports

COVID-19 infection in the Canadian household population

by Tracey Bushnik, Steven Earl, Jonathan Cabot and Janine Clarke

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ABSTRACT

Background

Certain population groups face a disproportionate burden of exposure to COVID-19. This study examined characteristics of Canadians living in private households in fall 2020 and winter 2021 who had been infected with COVID-19.

Data and methods

With an online questionnaire and an at-home finger-prick blood test, the Canadian COVID-19 Antibody and Health Survey was designed to estimate the seroprevalence of COVID-19 infection among people in private households in Canada. Data were collected from respondents aged 1 or older in the 10 provinces and the three territorial capitals, from November 2020 to April 2021. Descriptive statistics and logistic regression were used to identify characteristics that were associated with being seropositive for a past COVID-19 infection. Gender differences in observed associations were examined.

Results

After covariate adjustment, younger age and visible minority status were associated with an increased likelihood of being seropositive for a past COVID-19 infection. For males, having a visible minority status, having less education and living in a multi-unit dwelling increased the likelihood of being seropositive. Females were more likely to have been seropositive if they worked in health care in direct contact with others.

Interpretation

As Canada navigates the fifth and possibly a sixth wave of the pandemic, understanding who was more likely to be infected in earlier waves can help ongoing public health efforts to stop the transmission of COVID-19.

Keywords

burden, COVID-19, exposure, pandemic, SARS-CoV-2, seroprevalence, gender

AUTHORS

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What is already known on this subject?

- Certain population groups face a disproportionate burden of exposure to COVID-19.
- Seroprevalence and confirmed case studies worldwide show that people of working age, in racially marginalized groups and in essential occupations including health care are at increased risk of infection.
- Stopping the transmission of COVID-19 continues to be a public health priority.

What does this study add?

- The Canadian COVID-19 Antibody and Health Survey (CCAHS) is the first of its kind to provide national-level information about the seroprevalence of COVID-19 infection among people living in private households in Canada.
- This study uses the CCAHS to examine characteristics associated with a past COVID-19 infection.
- People of younger ages and people in a visible minority group were almost twice as likely as those of older ages or not in a visible minority group, respectively, to have been infected with COVID-19. Males and females with a past infection differed according to visible minority status, dwelling type, education and work status. A significant proportion of those with a past COVID-19 infection who reported no positive nose or throat swab test result also reported not experiencing symptoms.

Since the onset of the pandemic, studies worldwide have found that certain population groups face a disproportionate burden of exposure to COVID-19. These include people of working age, people in racially marginalized groups or who are at a social disadvantage and health care workers.¹⁻³ Not only are these groups at increased risk of infection, but some may also experience barriers to COVID-19 testing⁴ and vaccination.⁵ Gender and sex differences in exposure and susceptibility have also been reported, but results have varied across countries.⁶

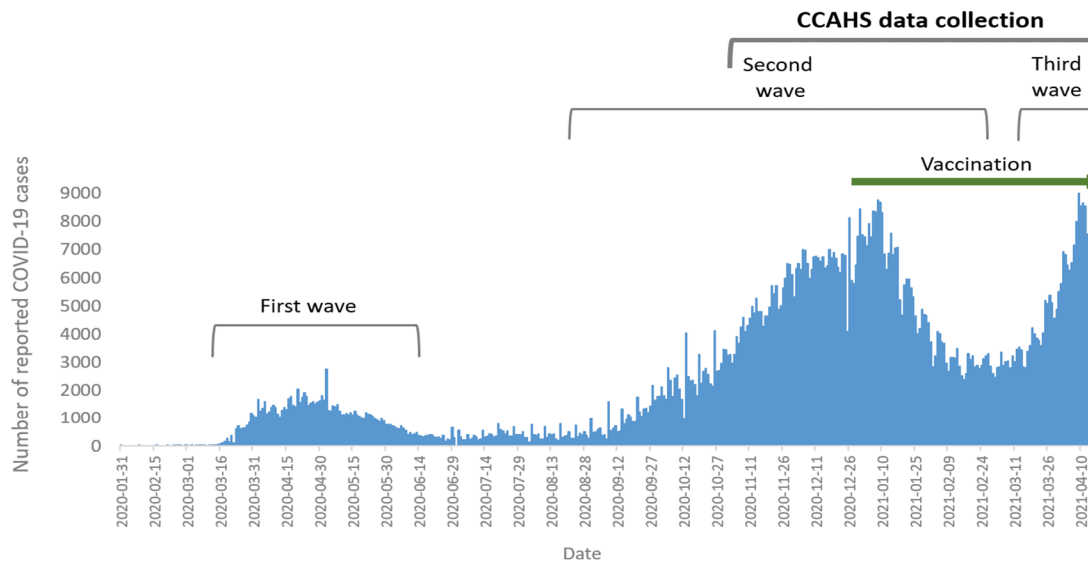
Exposure risk varies by these characteristics for a number of reasons. It may vary by gender because of occupational, risk-taking and health-seeking behaviour differences, and sex can influence a person's immune response or ability to resist or withstand infection.⁶ Younger age is a factor in the household population because children, youth and working-age people have an increased likelihood of exposure owing to more encounters with non-household members through active social behaviour, school, work or caring for others.⁷ Being part of a racialized or visible minority group is associated with an increased exposure risk because of the increased likelihood of living in higher-risk residential settings and working in higher-risk occupations.^{8,9} Housing can contribute to increased exposure through the amount of shared living space or amenities in the same household,¹⁰ in multi-unit buildings or in more densely populated communities.⁸ Working in health care or other essential occupations can contribute to increased exposure through more frequent and close contact with others who may be infected.¹¹

In Canada, the first wave of the pandemic began in March 2020 and peaked in mid-April 2020¹² (Figure 1). At that time, outbreaks in long-term care facilities accounted for the majority

of COVID-19-related deaths.¹³ The second wave emerged in August 2020 and peaked in early January 2021, followed closely by the third wave that peaked in April 2021.¹² Provisional weekly estimates of excess mortality—that is, mortality above the expected level that is directly or indirectly related to the pandemic—suggested that more than 9,000 excess deaths occurred in Canada during the second wave, with two-thirds of these excess deaths among adults aged 65 or older.¹⁴ Vaccination efforts began near the end of December 2020, with priority given to high-risk people owing to a limited initial vaccine supply. From December 2020 through the beginning of April 2021, about 15% of Canadians (about 5.8 million people)—mainly adults aged 80 or older, residents and staff of congregate living settings that provided care for seniors, health care workers, and adults living in Indigenous communities¹⁵—received at least one dose of a COVID-19 vaccine.¹⁶

The first of its kind at the national level, the Canadian COVID-19 Antibody and Health Survey (CCAHS) provides information about the prevalence of a past COVID-19 infection among people aged 1 or older living in private households in Canada. The CCAHS collected questionnaire and dried blood spot (DBS) data during the second and third waves of the pandemic, from November 2020 to April 2021 (Figure 1). Using these data, this study examines associations between a past COVID-19 infection and the characteristics of Canadians living in private households. It also examines gender differences in these associations. With the pandemic in its fifth and perhaps entering a sixth wave, understanding past patterns in COVID-19 infection and identifying who was at increased risk can help inform ongoing and future policy.

Figure 1
 COVID-19 and Canadian COVID-19 Antibody and Health Survey collection timeline.



Note: COVID-19 case count data are as reported in the COVID-19 daily epidemiology update published by the Public Health Agency of Canada. CCAHS = Canadian COVID-19 Antibody and Health Survey.

Source: Canadian COVID-19 Antibody and Health Survey.

Methods

Data source

The Canadian COVID-19 Antibody and Health Survey (CCAHS) is cross-sectional. It used a direct sampling frame for people aged 1 to 24 years and a multi-stage sampling frame for those aged 25 or older to select a sample of 47,900 people living in private households across the 10 provinces and the three territorial capitals. Selected respondents were asked to complete an online electronic questionnaire (EQ) and an at-home finger-prick blood test, called a dried blood spot (DBS) test. After filling in the EQ, respondents were asked to complete the DBS test and mail it using the provided pre-addressed envelope. Data were collected from November 2020 to April 2021, with the bulk of collection completed in January and February 2021 (86%). This yielded 11,026 questionnaire and DBS test responses for a 23% combined response rate. A survey weight to account for the complex sampling design and survey nonresponse was produced. Thus, weighted estimates from the CCAHS are representative of the target population. The CCAHS does not include people living on reserves and other Indigenous settlements in the provinces, individuals living on Canadian Forces bases, the institutionalized population or residents of certain remote regions—these groups account for approximately 3% of the Canadian population aged 1 or older. Details about the CCAHS design and weighting can be found in the user guide.¹⁷

The present analysis excluded 206 respondents who were seropositive for vaccination or who reported being vaccinated. The final analytical sample included 10,820 respondents of whom 207 had tested positive for antibodies indicating a past COVID-19 infection.

Measures

Seropositive for past COVID-19 infection

Completed DBS tests were sent to two reference laboratories that used a 384-wells format chemiluminescent enzyme-linked immunosorbent assay (ELISA) to test the DBS samples for detection of IgG antibodies against three antigens: the trimer of SARS-CoV-2 protein spike (S), the receptor binding domain (RBD) of spike and nucleocapsid (N). Laboratory staff followed standard operating procedures and uniform assay protocols to ensure similar results and consistent performance. Details about protocols and procedures can be found in the CCAHS user guide.¹⁷

A respondent whose DBS result was positive for two or more antigen tests and who did not report receiving a COVID-19 vaccine was deemed as seropositive for antibodies against SARS-CoV-2 because of a past COVID-19 infection.

Covariates

Respondents were asked sociodemographic and COVID-19 health-related questions in the EQ. Sex at birth and gender were equal for 99.5% of the analytical sample, and 100% of those

who were seropositive. This study examined gender (male, female), age groups (1 to 19, 20 to 59 and 60 or older), highest level of household education (postsecondary school graduate versus lower level) household size (one, two, three or four or more people), currently smoke tobacco (no, yes) and number of chronic conditions (none, one or two or more). Visible minority

status was assigned if the respondent reported a non-white cultural or racial background.

Adjusted household income quintiles were derived by using a modified version of the equivalence score method where total household income is adjusted by a weight factor based on the number of people in the household.¹⁸

Table 1

Characteristics of people who were seropositive for SARS-CoV-2 antibodies that indicate a past infection compared with people who were seronegative, Canada, November 2020 to April 2021

	Population distribution										
	Seropositive for past COVID-19 infection				Seronegative for past COVID-19 infection				Difference (%)	95% confidence interval	
	n	Weighted %	95% confidence interval		n	Weighted %	95% confidence interval			from	to
Total	205	100.0	...	...	10,615	100.0	...	...	...	...	...
Gender											
Female	105	50.0	41.6	58.4	5,870	54.1	52.7	55.4	-4.3	-12.8	4.3
Male	100	50.0	41.6	58.4	4,710	45.7	44.3	47.0	4.3	-4.3	12.8
Age group											
60 or older	40	14.4	10.0	20.3	3,160	27.2	21.2	34.2	-12.8 [§]	-20.0	-5.6
20 to 59	115	58.9	50.9	66.4	5,500	52.0	46.8	57.1	6.9	-1.7	15.5
1 to 19	50	26.7	20.2	34.4	1,955	20.8	18.0	23.9	5.9	-2.4	14.3
Visible minority status											
Not visible minority	145	64.9	56.0	72.9	9,275	79.6	77.9	81.3	-14.7 [§]	-23.4	-6.0
Visible minority	60	35.1	27.1	44.0	1,305	20.4	18.7	22.1	14.7 [§]	6.0	23.4
Highest level of household education											
Postsecondary school graduate	170	82.5	73.5	88.9	8,810	83.8	82.4	85.2	-1.4	-8.8	6.1
Less than postsecondary school graduation	35	17.5	11.1	26.5	1,790	16.2	14.8	17.6	1.4	-6.1	8.8
Adjusted household income quintile											
Income quintiles 2 to 5	170	79.9	72.3	85.9	8,765	80.0	78.8	81.1	0.0	-6.9	6.8
Income quintile 1 (lowest)	35	20.1	14.1	27.7	1,850	20.0	18.9	21.2	0.0	-6.8	6.9
Household size											
One person	25	7.6	4.3	12.9	2,175	12.6	10.7	14.9	-5.1 [§]	-9.5	-0.7
Two people	55	22.5	16.6	29.8	3,155	27.9	24.9	31.1	-5.4	-12.7	1.9
Three people	30	17.9	11.8	26.3	1,695	17.4	16.2	18.8	0.5	-6.8	7.7
Four or more people	95	52.0	43.6	60.4	3,590	42.0	37.8	46.4	10.0 [§]	0.4	19.7
Dwelling type											
Not a multi-unit	150	72.2	63.7	79.4	8,185	78.1	76.6	79.6	5.9	-1.9	13.8
Multi-unit	55	27.8	20.6	36.3	2,225	21.9	20.4	23.4	-5.9	-13.8	1.9
Work status in the past six months[†]											
Not in direct contact or did not work	115	60.9	52.6	68.6	5,905	64.4	62.3	66.5	-3.5	-11.8	4.7
Occupation other than health and in direct contact	70	30.3	23.4	38.2	3,990	31.6	29.8	33.5	-1.3	-8.9	6.3
In health occupation and in direct contact	20	8.8	4.6	16.2	545	3.9	3.3	4.7	4.9 ^{**}	-0.8	10.5
Reported symptoms in the past six months											
No	70	38.9	30.6	47.9	6,440	65.5	64.0	67.0	-26.6 [§]	-35.3	-17.9
Yes	135	61.1	52.1	69.4	4,175	34.5	33.0	36.0	26.6 [§]	17.9	35.3
Positive nose or throat swab test result[‡]											
No	95	46.2	37.7	54.8	10,580	99.6	99.3	99.7	-53.4 [§]	-62.0	-44.8
Yes	115	53.8	45.2	62.3	30	0.4	0.3	0.7	53.4 [§]	44.8	62.0
Currently smoke tobacco											
No	195	90.0	81.5	94.9	9,745	92.3	91.5	93.0	-2.3	-8.8	4.3
Yes	10	10.0	5.1	18.5	830	7.7	7.0	8.5	2.3	-4.3	8.8
Number of chronic conditions											
None	145	76.9	69.6	82.8	7,100	71.9	69.6	74.2	4.9	-2.0	11.8
One	45	17.5	12.4	24.2	2,295	20.0	18.5	21.6	-2.5	-8.5	3.6
Two or more	15	5.6	2.8	10.8	990	8.1	7.0	9.3	-2.5	-6.4	1.5

... not applicable

[†] respondents younger than 15 included in the "not in direct contact or did not work" category

[‡] no positive nose or throat swab test result includes never had a test or their nose or throat swab test result was negative

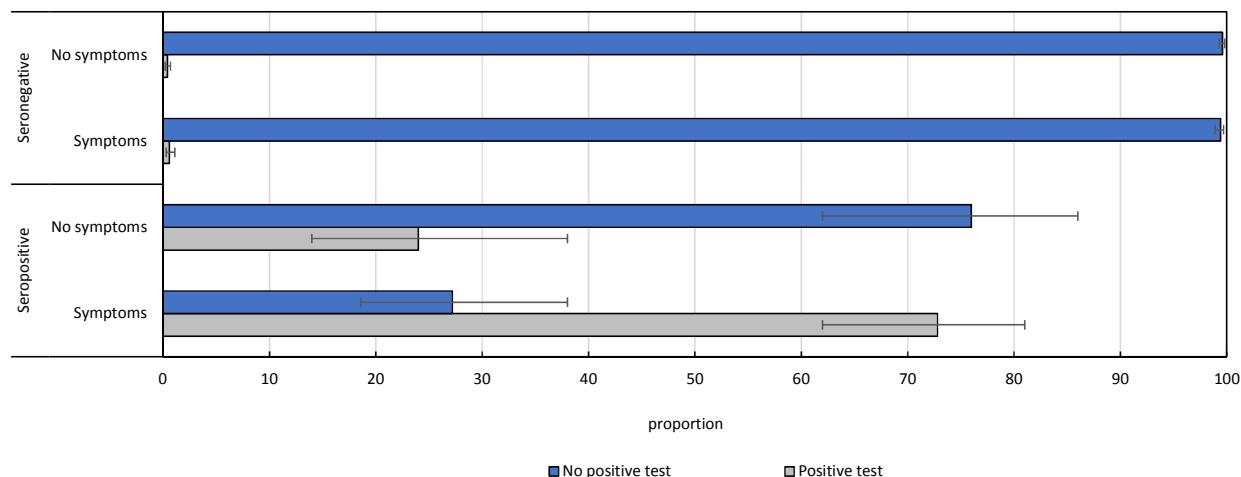
[§] indicates difference between estimate for seropositive for past COVID-19 infection and estimate for seronegative for past COVID-19 infection statistically different from zero at p < 0.05

^{**} indicates difference between estimate for seropositive for past COVID-19 infection and estimate for seronegative for past COVID-19 infection statistically different from zero at 0.05 ≤ p < 0.10

Notes: Sample sizes have been randomly rounded to base 5. Weighted proportions are based on unrounded estimates. Multi-unit dwelling type includes duplex, low-rise apartment (fewer than five storeys) or high-rise apartment (five storeys or more). Respondents were categorized as "did not report symptoms in the past six months" if they responded no to each of the following: cough, fever, chills, sore throat, shortness of breath or difficulty breathing, pain, runny nose, nausea, vomiting or diarrhea, headache, general weakness, or new loss of taste or smell.

Source: Canadian COVID-19 Antibody and Health Survey.

Figure 2
Proportion of positive versus no positive nose or throat swab test results by presence of COVID-19 symptoms, among people who were seropositive versus people who were seronegative, Canada, November 2020 to April 2021



Note: Error bars indicate 95% confidence intervals.
Source: Canadian COVID-19 Antibody and Health Survey.

Multi-unit dwelling type included duplex, low-rise apartment (fewer than five storeys) or high-rise apartment (five storeys or more) versus single detached, double, row or terrace.

Respondents who reported working in direct contact with others (not virtually or over the phone) were asked their occupation and were categorized as being in health care if their first level National Occupational Classification (NOC) 2016 code was “3”. If the NOC 2016 was not “3”, they were categorized as being in an occupation other than health care. Respondents younger than 15, respondents who did not work in direct contact with others or respondents who did not work were all combined into the same work status category.

Respondents were categorized as having a positive nose or throat swab test result if they reported receiving a positive result versus having no positive test result if they reported either a negative result or that they never had a nose or throat swab test.

Respondents were categorized as not reporting COVID-19 symptoms in the past six months if they answered “no” to each of the following: cough, fever, chills, sore throat, shortness of breath or difficulty breathing, pain, runny nose, nausea, vomiting or diarrhea, headache, general weakness or new loss of taste or smell.

Analytical techniques

Proportions, differences and 95% confidence intervals (CIs) were estimated to examine the characteristics of people with a past COVID-19 infection versus those without. Multivariable logistic regression models with listwise deletion (n=429 of 10,820 were excluded) were used to estimate the association between population characteristics (gender, age group, visible minority status, education, income, household size, dwelling

type and work status) and a past COVID-19 infection. Adjusted seroprevalence estimates, differences, ratios and their 95% CIs were estimated from the full model by calculating average marginal effects, adjusting for all covariates. Additional models—each with an interaction term between gender and one covariate, adjusting for all remaining covariates—assessed whether the association between a specific characteristic and the outcome differed by gender. Supplementary analyses examined whether smoking or the number of chronic conditions played a role in gender differences.

All estimates were weighted by using the survey weight, and the sampling variance was calculated by using the bootstrap weights. Statistical significance of t-tests and model parameters was assessed at two levels: $p < 0.05$ and $0.05 \leq p < 0.10$. All analyses were conducted in SAS 9.4 and SAS-callable SUDAAN 11.0.3.

Results

People in private households who were seropositive for a past COVID-19 infection were similar to those who were seronegative according to education, income, type of dwelling, smoking and number of chronic conditions (Table 1). However, a lower proportion of those with a past infection were aged 60 or older compared with those who had not been infected (14% versus 27%) or lived alone (8% versus 13%), and a higher proportion were in a visible minority group (35% versus 20%) or in a household of four or more people (52% versus 42%). Moreover, a higher proportion of those with a past infection reported experiencing symptoms in the previous six months

Table 2
Unadjusted and adjusted SARS-CoV-2 antibody seroprevalence because of past infection, Canada, November 2020 to April 2021

	Unadjusted seroprevalence			Adjusted seroprevalence								
	(A)			(B)			(C)			(D)		
	%	95% confidence interval		%	95% confidence interval		Difference (%)	95% confidence interval		Ratio	95% confidence interval	
from		to	from		to	from		to	from		to	
Gender												
Female (ref)	2.4	1.8	3.3	2.4	1.8	3.3	...	...	...	1.0	...	...
Male	2.9	2.2	3.7	3.0	2.3	3.9	0.6	-0.3	1.4	1.2	0.9	1.8
Age group												
60 or older (ref)	1.4	0.9	2.2	1.7	1.0	2.7	...	...	...	1.0	...	...
20 to 59	2.9	2.2	3.9	2.9	2.2	3.8	1.2 [§]	0.3	2.1	1.7	1.0	3.0
1 to 19	3.3	2.4	4.6	3.2	2.2	4.7	1.6 [§]	0.1	3.0	1.9	0.9	4.1
Visible minority status												
Not visible minority (ref)	2.2	1.6	2.8	2.3	1.8	3.0	...	...	...	1.0	...	...
Visible minority	4.4	3.2	6.1	3.9	2.7	5.5	1.6 [§]	0.3	2.8	1.7	1.1	2.5
Highest level of household education												
Postsecondary school graduate (ref)	2.6	2.0	3.4	2.5	1.9	3.4	...	...	...	1.0	...	...
Less than postsecondary school graduation	2.8	1.9	4.2	3.6	2.4	5.4	1.1	-0.6	2.7	1.4	0.8	2.5
Adjusted household income quintile												
Income quintiles 2 to 5 (ref)	2.6	2.1	3.3	2.8	2.2	3.5	...	...	...	1.0	...	...
Income quintile 1 (lowest)	2.6	1.6	4.1	2.4	1.4	3.9	-0.4	-1.4	0.6	0.9	0.6	1.3
Household size												
One person (ref)	1.6	0.9	2.9	1.7	0.9	3.3	...	...	...	1.0	...	...
Two people	2.1	1.4	3.2	2.5	1.6	3.8	0.8	-0.4	2.0	1.5	0.7	3.4
Three people	2.7	1.6	4.5	2.8	1.6	4.7	1.1	-0.4	2.6	1.6	0.6	4.1
Four or more people	3.2	2.5	4.0	3.0	2.3	3.9	1.3 [§]	0.0	2.6	1.8	0.7	4.5
Dwelling type												
Not a multi-unit (ref)	2.4	1.9	3.2	2.5	1.9	3.2	...	...	...	1.0	...	...
Multi-unit	3.3	2.3	4.8	3.6	2.4	5.2	1.1	-0.2	2.4	1.5	0.9	2.3
Work status in the past six months[†]												
Not in direct contact or did not work (ref)	2.5	1.9	3.2	2.6	2.0	3.4	...	...	...	1.0	...	...
Occupation other than health and in direct contact	2.5	1.8	3.6	2.5	1.7	3.6	-0.1	-1.0	0.8	1.0	0.7	1.4
In health occupation and in direct contact	5.7	2.7	11.8	6.0	2.8	12.4	3.4	-0.4	7.3	2.3	1.1	4.9

... not applicable

[†] respondents younger than 15 included in the "not in direct contact or did not work" category

[§] indicates difference between adjusted seroprevalence estimate and the reference category (ref) statistically different from zero at p < 0.05

Notes: Gender, age group, visible minority status, highest level of household education, adjusted household income quintile, household size, dwelling type and work status were included in the adjusted model. Multi-unit dwelling type includes duplex, low-rise apartment (fewer than five storeys) or high-rise apartment (five storeys or more).

Source: Canadian COVID-19 Antibody and Health Survey.

(61% versus 35%) or a positive nose or throat swab test result (54% versus 0.4%). Figure 2 shows that among people who were seropositive, 76% of those without symptoms and 27% of those with symptoms reported no previous positive swab test result. Among those who were seronegative, almost 100% reported no positive swab test result, regardless of the presence of symptoms.

Table 2 presents unadjusted (column A) and adjusted seroprevalence estimates, differences and ratios (columns B to D). After controlling for gender, visible minority status, education, income, household size, dwelling type and work status, people younger than 60 had a higher average adjusted seroprevalence of a past COVID-19 infection. The adjusted prevalence ratios (column D) indicate that people younger than 20 were 1.9 times (95% CI: 0.9, 4.1) and those between 20 and 59 were 1.7 times (95% CI: 1.0, 3.0) more likely to have been infected than people aged 60 or older. Moreover, people who reported being in a visible minority group were 1.7 times (95% CI: 1.1, 2.5) more likely to have been infected with COVID-19 than those who were not in a visible minority group, regardless of other characteristics.

Table 3 presents the effect of gender on the observed associations. After covariate adjustment, the higher average adjusted seroprevalence of a past infection among those who reported being in a visible minority group was predominantly among males and not females. Visible minority males were 2.5 times more likely (95% CI: 1.4, 4.2) to have been infected than non-visible minority males, but there was little difference for females. Males who lived in a multi-unit dwelling were twice as likely (95% CI: 1.2, 3.6) as males who did not live in a multi-unit dwelling to have been infected, but there was no association between dwelling type and a past infection for females. The results also suggest that males with less than a postsecondary school graduation may have been twice as likely (95% CI: 1.0, 3.9) as males with more education to have been infected and that females who worked in a health occupation in direct contact with others may have been 2.5 times more likely (95% CI: 1.0, 6.2) to have been infected compared with females who did not work in direct contact with others.

Table 3
Interaction between gender and other characteristics in model-adjusted SARS-CoV-2 antibody seroprevalence because of past infection, Canada, November 2020 to April 2021

	Adjusted seroprevalence											
	Females						Males					
	95% confidence interval			Ratio	95% confidence interval			95% confidence interval			95% confidence interval	
%	from	to	%		from	to	%	from	to	Ratio	from	to
Age group												
60 or older (ref)	1.4	0.5	3.8	ref	...	...	2.0	1.2	3.2	ref	...	...
20 to 59	2.7	1.9	3.8	1.9	0.3	12.8	3.1	2.1	4.6	1.6	0.8	3.0
1 to 19	2.8	1.7	4.7	2.0	0.2	18.4	3.7	2.2	6.3	1.9	0.8	4.2
Visible minority status												
Not visible minority (ref)	2.4	1.7	3.3	ref	...	...	2.2	1.6	3.1	ref	...	...
Visible minority	2.5	1.4	4.5	1.1	0.6	2.0	5.4	3.5	8.3	2.5	1.4	4.2
Highest level of household education												
Postsecondary school graduate (ref)	2.5	1.8	3.5	ref	...	...	2.6	1.9	3.7	ref	...	...
Less than postsecondary school graduation	2.1	1.2	3.7	0.9	0.4	1.9	5.2	3.0	8.9	2.0	1.0	3.9
Adjusted household income quintile												
Income quintiles 2 to 5 (ref)	2.7	2.0	3.7	ref	...	...	2.9	2.1	3.9	ref	...	...
Income quintile 1 (lowest)	1.6	0.7	3.3	0.6	0.3	1.2	3.4	1.8	6.2	1.2	0.7	2.1
Household size												
One person (ref)	2.2	0.9	5.3	ref	...	...	1.0	0.4	2.7	ref	...	...
Two people	2.0	1.0	3.8	0.9	0.3	2.9	3.2	2.0	5.1	3.2	0.5	22.5
Three people	2.3	1.0	5.4	1.0	0.3	4.2	3.3	1.7	6.5	3.3	0.4	24.0
Four or more people	2.8	1.9	4.1	1.3	0.3	5.7	3.2	2.2	4.8	3.2	0.6	17.1
Dwelling type												
Not a multi-unit (ref)	2.4	1.7	3.5	ref	...	...	2.5	1.8	3.4	ref	...	...
Multi-unit	2.4	1.4	4.0	1.0	0.5	2.0	5.0	3.1	8.1	2.0	1.2	3.6
Work status in the past six months[†]												
Not in direct contact or did not work (ref)	2.4	1.6	3.6	ref	...	...	2.7	2.0	3.7	ref	...	...
Occupation other than health and in direct contact	1.9	1.2	2.9	0.8	0.4	1.5	3.1	1.9	5.1	1.2	0.7	1.9
In health occupation and in direct contact	6.1	2.4	14.5	2.5	1.0	6.2	4.1	1.5	10.6	1.5	0.6	4.1

... not applicable

[†] respondents younger than 15 included in the "not in direct contact or did not work" category

Notes: Estimates were produced from separate models in which there was interaction between gender and a single covariate, adjusting for all remaining covariates. Ref indicates reference category. Multi-unit dwelling type includes duplex, low-rise apartment (fewer than five storeys) or high-rise apartment (five storeys or more).

Source: Canadian COVID-19 Antibody and Health Survey.

Discussion

The CCAHS reported that about 2.6% of Canadians living in private households between November 2020 and April 2021 had SARS-CoV-2 antibodies indicating a past infection in their blood.¹⁹ The present analysis found that younger age and visible minority status were associated with an increased likelihood of a past infection regardless of other characteristics. It also found that gender modified the associations between being part of a visible minority group, living in a multi-unit dwelling, having less than a postsecondary education or working in a health occupation in direct contact with others and the likelihood of a past infection, after covariate adjustment.

The finding of increased infection risk among younger people is in line with results from other studies. While susceptibility to COVID-19 is greater for older people, younger people have increased exposure through school, working or caring for others.^{7,20}

A higher prevalence of COVID-19 has been observed among people in racialized groups in Canada and in other countries such as the United States and the United Kingdom.^{2,21-23} The present study found an increased likelihood of a past infection among those who reported being in a visible minority, but

mainly for males and not females. Gender differences in health behaviours and health status may partly explain this finding. A meta-analysis of 57 studies predominantly from China found a higher prevalence of smoking and comorbidities among males, and that it was associated with increased prevalence of COVID-19.²⁴ In supplementary analyses, the present study also found that a higher proportion of visible minority males smoked (8%) and reported at least one chronic condition (22%) compared with visible minority females (1.5% and 15% respectively).

Interaction in common areas such as elevators, stairways and laundry rooms in multi-unit residential buildings represents opportunity for infection transmission.²⁵ The present study found an increased likelihood of a past infection for males, but not for females, who lived in a multi-unit dwelling. The multi-unit dwellings of males may have differed in some way that increased the risk of exposure (e.g., number of elevators, number of floors, number of shared spaces), or there may have been other underlying differences. For example, a higher proportion of males than females in multi-unit dwellings smoked (13% versus 8%), a behaviour that has been linked to higher COVID-19 prevalence among males.²⁴ The present study also found that males who had not graduated from postsecondary school were more likely to have been infected, but not females. One study based on repeated cross-sectional surveys found that a lower education level for males, but not

females, was associated with less factual knowledge about COVID-19. Less factual knowledge was then associated with reduced adherence to some protective behaviours,²⁶ which in turn could increase the risk of exposure to COVID-19.²⁷

Increased infection risk among health care workers has been reported worldwide.^{1,28} The present study found that females, but not males, working in health care in direct contact with others had a higher likelihood of past infection compared with those who did not work in direct contact with others. This gender-specific finding may have been related to occupation type. In the present study, the most common occupation among females working in health care was registered nurse (29%) or nurse's aide, orderly or patient services (16%), roles associated with inpatient settings and higher COVID-19 exposure risk.²⁹ On the other hand, the most common occupation for males in health care in direct contact with others was pharmacist (15%) or general practitioner or family physician (14%).

This study also found that four out of 10 people who were seropositive because of a past infection reported not experiencing any symptoms in the previous six months. Furthermore, three-quarters of these people reported they had not previously received a positive nose or throat swab test result. Together, these findings speak to the issue of asymptomatic COVID-19 infection and the challenge of preventing transmission when people may be unaware of carrying the virus.

The COVID-19 landscape continues to evolve in Canada. COVID-19 vaccines are now widely available, and to date about 85% of Canadians aged 5 or older are fully vaccinated.¹⁶ Nevertheless, certain groups who were at greater risk of infection according to the CCAHS may continue to be at greater risk owing to emerging variants of concern, vaccine hesitancy or lower rates of vaccination.^{16,30}

Strengths and limitations

A key strength of this study is that it is based on a nationally representative survey of Canadians—past COVID-19 infection status was ascertained through a combination of questionnaire data and a blood test. The main limitation of this study is its small number of seropositive respondents. It resulted in less statistical power and wider CIs around estimates, and prevented further disaggregation of results (e.g., by occupation type, by visible minority group). Also, the CCAHS recommends that the additional variance component originating from the sensitivity and specificity of the laboratory tests be incorporated into estimates of seroprevalence.¹⁷ However, the suggested method could not be followed because it does not pertain to model-adjusted seroprevalence. Therefore, even though the sensitivity and specificity of the tests used in CCAHS were estimated at 100%,¹⁷ the results presented here may not reflect the total variance associated with estimates of seroprevalence. Moreover, despite adjustments and calibrations reflected in the survey weights, there is still a risk of non-response bias in the survey estimates owing to the high degree of non-response to the CCAHS.

Conclusion

Being of younger ages, being male in a visible minority group or with less than a postsecondary education or living in a multi-unit dwelling and being female in a health occupation in direct contact with others were characteristics associated with an increased likelihood of a past COVID-19 infection in fall 2020 to winter 2021 in Canada. As the country navigates the fifth and possibly a sixth wave of the pandemic, understanding who was more likely to be infected in earlier waves can help ongoing public health efforts to stop the transmission of COVID-19.

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