SUPPLEMENTAL

Extensive SARS-CoV-2 testing reveals BA.1/BA.2 asymptomatic rates and underreporting in school children – Supplemental material

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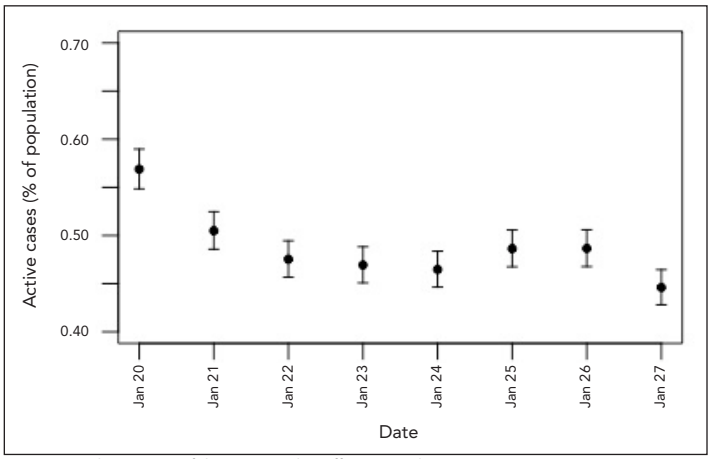
Supplemental material A: Newfoundland and Labrador provincial case counts

Reported positivity

Figure S1 shows the number of active cases as a percentage of the population of Newfoundland and Labrador (NL) (estimated to be 510,550 (1)) based on the Public Service Advisory COVID-19 updates that report the number of new cases (2), and assuming a recovery time of seven days. For data reported by the government of NL, the definition of active cases was changed from 10 to 7 days for the data reported from January 8, 2022, onward. As we are interested in comparing testing results with the number of active cases in the province around these dates (recall that rapid tests were performed on January 22 and January 25), we prefer to derive the number of active cases from new cases such that we can use a consistent recovery time throughout the time period of interest.

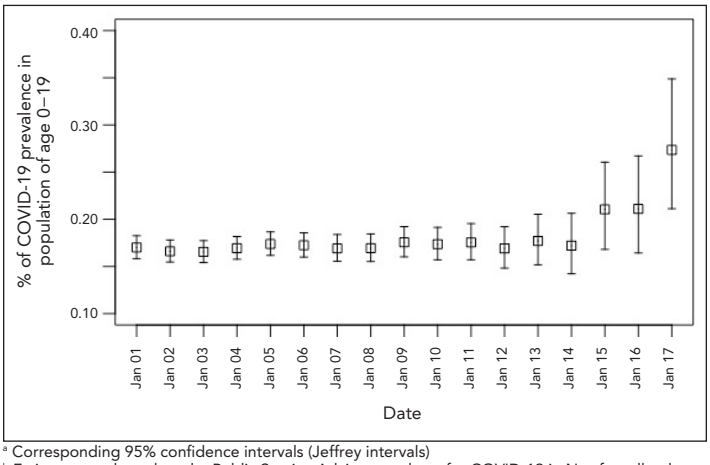
Figure S1: Active cases as a percentage of the population of Newfoundland and Labrador, between January 20 and January 27, 2022[a,b]



[a] Corresponding 95% confidence intervals (Jeffrey intervals)
[b] Estimates are derived from the Public Service Advisory updates reporting new cases of COVID-19 (2) and assuming a recovery time of seven days

The mean percentage of people in NL reported as active COVID-19 cases from January 20 to January 27 was estimated to be 0.49%. After January 17, case reporting by age group was no longer provided by the province. To estimate COVID-19 prevalence in K–12 students we multiply this estimate by the percentage of cases occurring in individuals aged 0–19 years, averaged between January 1 and January 14 (**Figure S2**), and weighted by the total population aged 0–19 years old (estimated to be 93,910 (1)). We estimate reported COVID-19 prevalence in youth at the time of the rapid antigen testing to be 0.45%.

Figure S2: Percentage of reported COVID-19 cases occurring in individuals aged 0–19 years, between January 1 and January 17, 2022[a,b]



[a] Corresponding 95% confidence intervals (Jeffrey intervals)
[b] Estimates are based on the Public Service Advisory updates for COVID-19 in Newfoundland and Labrador (2), and on census data (1). For our computations, we consider only the average of the daily reported percentages from January 1 to January 14, as the percentage of reported COVID-19 cases occurring in youth seems to be fairly constant during this period of time. After January 14, we can observe a trend of a higher percentage of cases in youth, although uncertainty for these dates is higher. On January 17, 2022, the province stopped reporting age-structured case counts, and this trend cannot be confirmed by available data

Reported household positivity

We consider the reported COVID-19 prevalence in NL (i.e. 0.49%, as derived above) to estimate household positivity. Given that we cannot differentiate between positive tests reported from households with or without students in grades K–12, we estimate COVID-19 prevalence at provincial level, where the total number of households in Newfoundland and Labrador is 223,255 (1).

Before January 24, 2022, rapid antigen testing was recommended for household close contacts of someone with COVID-19 who has symptoms (3). Close contacts testing positive on a rapid antigen test (RAT), were recommended to book a polymerase chain reaction (PCR) test. From January 24, testing was recommended only for non-household contacts, with specific vaccination status (4). If we assume that only one test per household was reported in a single day, we obtain a household positivity of 0.49% × population (NL) ÷ 223,255 = 1.2%.

Supplemental material B: Survey

COMPLETE 1 SURVEY FOR ALL K–12 STUDENTS IN YOUR HOUSEHOLD

CONSENT TO PARTICIPATE IN THE RESEARCH STUDY

ELIGIBILITY

You are a parent or guardian of K–12 student(s) in Newfoundland and Labrador, and
K–12 student(s) in your household completed at least one rapid antigen test on January 22 and/or January 25.

Do you consent to participate in the research study? (YES/NO)

Enter the first 3-digits of your postal code, i.e. A1A: _____
What is your Regional Health Authority?

- ◯ Eastern Health
- ◯ Central Health
- ◯ Western Health
- ◯ Labrador Grenfell

At the recommendation of the Department of Health and Community Services, on January 22 and 25 many students in Newfoundland and Labrador completed COVID-19 rapid antigen tests prior to returning to school.

For question 3. (below) the determination of "no symptoms" or "with symptoms" refers to the period January 19 to 29. For a definition of symptoms, please see: https://www.gov.nl.ca/covid-19/public-health-guidance/covid-19/symptoms

For the FIRST rapid test(s) completed on January 22, the number of rapid tests from your household:

	Negative	Positive – no symptoms	Positive – with symptoms
Elementary student(s): K–6			
Junior high & high school student(s)			

For question 4. (below) the determination of "no symptoms" or "with symptoms" refers to the period January 22 to February 1. For a definition of symptoms please see: https://www.gov.nl.ca/covid-19/public-health-guidance/covid-19/symptoms

For the SECOND rapid test(s) completed on January 25, the number of rapid tests from your household:

	Negative	Positive – no symptoms	Positive – with symptoms
Elementary student(s): K–6			
Junior high & high school student(s)			

Supplemental material C: Sensitivity and specificity

Table S1: Data used to derive the averaged sensitivity of repeated testing

Days from exposure (test 1)	Days from exposure (test 2)	Viral load (test 1) [log10 units]	Viral load (test 2) [log10 units]	Sensitivity (test 1)	Sensitivity (test 2)	Sensitivity for repeated testing
—	0	0	3.0	—	16.9%	16.9%
—	1	0	5.0	—	64.0%	64.0%
—	2	0	7.0	—	98.0%	98.0%
0	3	3.0	9.0	16.9%	99.3%[a]	99.42%
1	4	5.0	9.0	64.0%	99.3%[a]	99.75%
2	5	7.0	8.2	98.0%	99.3%	99.986%
3	6	9.0	7.6	99.3%[a]	99.3%	99.995%
4	7	9.0	7.0	99.3%[a]	98.0%	99.986%
5	8	8.2	6.6	99.3%	98.0%	99.986%
6	9	7.6	6.2	99.3%	94.1%	99.959%
7	10	6.0	6.0	98.0%	94.1%	99.88%
8	11	6.6	5.6	98.0%	94.1%	99.88%
9	12	6.2	5.4	94.1%	84.3%	99.07%
10	13	6.0	5.2	94.1%	84.3%	99.07%
11	14	5.6	5.0	94.1%	84.3%	99.07%
12	—	5.4	—	84.3%	—	84.3%
13	—	5.2	—	84.3%	—	84.3%
14	—	5.0	—	84.3%	—	84.3%
Averaged sensitivity						90.44%

[a] We choose sensitivity for a viral load of 9 $\log^{10}$ units (not provided in (5)) to be equal to the sensitivity of a viral load of 8 $\log^{10}$ Units

Estimations of viral load are given in log units (e.g. 5 log units=100,000 copies/mL). Sensitivity at different viral loads during infection (rounded to the nearest integer log unit) are obtained from an Ontario Science Table publication (5). Sensitivity for repeated testing is the probability of obtaining a positive test if infected on either January 22 or January 25. Total average sensitivity is the averaged sensitivity of obtaining a positive test on January 22 or on January 25, assuming uniform distribution of exposure times. We consider sensitivities between day 0 and day 14 after exposure.

Sensitivity

To determine the overall probability of testing positive if infected on either January 22 or January 25, we consider sensitivity values at different viral loads to a rapid antigen test reported by the Ontario Science Table (5), based on data from Peto (6).

Additionally, we consider estimates of viral load during infection to determine test sensitivity from day 0 to day 14 after exposure (from Jüni *et al.* (5), based on data from Li *et al.* (7) and Kang *et al.* (8). As viral load curves for Omicron (with various vaccination statuses) are currently not known, we use viral load curves derived for the Delta variant, therefore assuming similarities in the analytical sensitivity of RATs to the Delta and Omicron variants (9). Note that sensitivities can vary by manufacturers (10).

To estimate sensitivity of repeated testing, we derive the probability of testing positive if infected when a second test is performed three days after the first one (e.g. the first test is performed on day 2 after exposure, while the second test is performed on day 5 after exposure), taking into account differences in viral load at different days after exposure. Estimates are provided in Table S1. For each of the dates considered, we have

Equation 1:

$$\text{Sensitivity of repeated testing} = s_1 + s_2 - s_1 s_2,$$

where s_1 is the sensitivity of test 1 (i.e. the test performed on January 22) and s_2 is the sensitivity of test 2 (i.e. the test performed on January 25). The total averaged sensitivity σ^{+}=0.9044 is obtained by averaging the sensitivity of repeated testing when considering uniform distribution of exposure times.

Specificity

Specificity does not depend on viral load and is assumed to be the same on January 22 and on January 25. As we consider positive cases as individuals testing positive on either January 22 or January 25, the specificity of repeated testing equals the probability of single testing. We choose σ^{-}=0.994%, based on the meta-analysis of Parvu *et al.* (11), indicating that it is highly unlikely to test positive if uninfected.

Supplemental material D: Data handling

To understand how testing results differed between January 22 and January 25 we examine the reporting of 69 households out of 1,278 that reported different results on the two dates. We found the following noteworthy changes between the two dates:

- **Positive to no report:** Parents and guardians were instructed not to conduct a second test on January 25, if the first test on January 22 were positive. We counted nine households that reported positive cases on January 22 and no testing on January 25, presumably because of following the provincial guidelines.
- **Positive asymptomatic to symptomatic:** Four households reported a change from asymptomatic positive cases on January 22, to positive symptomatic cases on January 25, possibly indicating that cases reported as asymptomatic were instead pre-symptomatic cases. The distinction between symptomatic and asymptomatic cases was based on participants' self-assessment, and it is possible that pre-symptomatic cases may have been reported as asymptomatic instead.
- **Negative to positive:** We found that 29 households reported negative cases on January 22, and positive cases on January 25 (16 asymptomatic and 13 symptomatic), likely indicating latent infections, where the viral load was not high enough to be detected by the first test, but successively increased enough to lead to a positive result three days later.
- **Positive to negative:** We found that three households reported cases changing from positive to negative between January 22 and 25 (one household reported one case changing from asymptomatic positive to negative, one household reported one case changing from symptomatic positive to negative, and one household reported one case changing from asymptomatic positive to negative and one case changing from symptomatic positive to negative). This change could be due to recovery (particularly for the household reporting a symptomatic positive case and for the household reporting two positive tests, both changing to negative three days later), or to a false positive result, although multiple studies have shown that the probability of testing positive if uninfected is very low (e.g. 0.006% (11)). We consider positive households as households that reported at least one positive result on January 22 or 25, and therefore according to our definition these households were considered positive.
- **Different total number of reported tests:** We found that 36 households reported a different total number of tests performed on January 22 and January 25. This difference may be due to students being in different households on the two dates, especially given that the first day was to be completed on a Saturday, while the second test was to be completed on a Tuesday, the morning before schools' reopening.

A detailed overview of this data is provided in the publicly accessible database.

Supplemental material E: Estimating underreporting from COVID-19 Immunity Task Force serology data

Provincial population sizes are from 2021 census estimates (1). For January 15 and February 12, 2022 (a 28-day period), cumulative reported cases were downloaded from the Public Health Agency of Canada website (12). The cumulative percentage of the population infected are estimates reported by the COVID-19 Immunity Task Force (13) derived from serology of Canadian Blood Services and Hema-Quebec donations. Seroconversion occurs 9–12 days after symptom onset (14), and serology data for comparison to the reported cases is considered from January 28 to February 25, 2022 (a 28-day period, offset by 13 days relative to the dates for the reported cases). The number of underreported cases per reported case was calculated as the difference in the percentage of the population infected as estimated by the serology, divided by the difference in the percentage of the population reported as infected.

On December 24, 2021, most residents of Nova Scotia became ineligible to be tested under the provincial testing system, and were instead directed to complete rapid tests, tests that would identify infections, but where positive results were not reported in the provincial case counts (15). All other provinces, except for NL and Prince Edward Island, had similar testing eligibility requirements, i.e., testing eligibility under the provincial systems was restricted to high-risk groups (i.e. hospital patients and the elderly), and individuals in contact with high-risk groups (i.e. patient-facing healthcare workers) (16), and with the results of testing completed outside the provincial system not included in provincial case counts.

Prince Edward Island introduced an appointment-based system for COVID-19 testing on June 8, 2022, but unlike all other Canadian provinces, never introduced restricted eligibility requirements for provincial testing.

Only on March 17, 2022 did NL introduce restrictions to testing eligibility (17) that were similar to the restricted eligibility enacted in all other provinces, except Prince Edward Island, by early January 2022. On January 4, 2022, testing eligibility in NL excluded symptomatic contacts of cases (3). On January 24, 2022, testing eligibility excluded household members of cases and symptomatic close contacts of cases. However, asymptomatic close contacts of cases (non-household members) and symptomatic individuals that were not a close contact were still recommended for testing under the provincial system (4), such that testing eligibility in NL was relatively unrestricted until March 17, 2022, when compared to all other provinces except Prince Edward Island.

Table S2: Underreporting of COVID-19 cases for January to February 2022, calculated from the COVID-19 Immunity Task Force serology data

Province	Population size	Cumulative reported cases to Jan 15, 2022	Cumulative reported cases per capita to Jan 15, 2022	Cumulative reported cases to Feb 12, 2022	Cumulative reported cases per capita to Feb 12, 2022	Seropositivity to Jan 28, 2022 (95% CI)	Seropositivity to Feb 25, 2022 (95% CI)	Estimated unreported cases per reported case
British Columbia	5,000,879	295,904	5.9%	339,736	6.8%	15.9% (13.4, 18.5)	31.4% (28.3, 34.5)	17.2
Alberta	4,262,635	439,320	10.3%	514,251	12.1%	20.5% (17.7, 23.5)	36.1% (32.6, 39.6)	8.7
Saskatchewan	1,132,505	98,699	8.7%	125,756	11.1%	14.7% (12.0, 17.4)	28.0% (24.3, 31.6)	5.5
Manitoba	1,342,153	107,838	8.0%	125,844	9.4%	22.6% (19.5, 25.8)	31.9% (28.1, 35.6)	6.6
Ontario	14,223,942	937,636	6.6%	1,070,455	7.5%	16.4% (13.8, 19.1)	26.2% (23.0, 29.5)	10.9
Quebec	8,501,833	806,920	9.5%	899,260	10.6%	14.3% (8.9, 20.2)	28.8% (22.3, 35.8)	13.2
New Brunswick	775,610	22,359	2.9%	32,610	4.2%	3.7% (2.4, 5.4)	11.0% (8.2, 14.3)	5.6
Nova Scotia	969,383	30,101	3.1%	42,230	4.4%	5.4% (3.5, 7.4)	15.8% (12.3, 19.6)	8.0
Prince Edward Island	154,331	4,118	2.7%	10,105	6.6%	2.2% (1.1, 3.9)	6.0% (3.2, 9.8)	1.0
Newfoundland and Labrador	510,550	12,406	2.4%	19,954	3.9%	2.7% (1.3, 4.6)	6.1% (3.6, 9.2)	2.3

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