In Canada, by May 20, 2020, there were 78,500 cases of coronavirus disease 2019 (COVID-19), with 5800 deaths. Large urban centres such as the Greater Toronto Area (GTA) shouldered the highest burden. By May 20, the 16,490 cases detected in the GTA’s population of 6.8 million represented 21% of cases in the country, more than two-thirds of cases in Ontario and a diagnosis per capita rate 1.5 times that of Ontario overall. As in past outbreaks of respiratory virus, congregate settings were disproportionately affected by COVID-19 and across Canada. Settings such as long-term care homes and homeless shelters were vulnerable partly owing to design barriers (e.g., shared living quarters and communal spaces) to physical distancing, and underresourcing of infection prevention and control measures.

Lessons from past epidemics suggest that disproportionate risks across settings contribute to the spread and outcomes of infection. Thus, a key feature of an epidemic response is heterogeneity across micro-epidemics among specific populations and settings may reflect underlying heterogeneity in transmission risks, necessitating setting-specific COVID-19 prevention and mitigation strategies.

Background: Congregate settings have been disproportionately affected by coronavirus disease 2019 (COVID-19). Our objective was to compare testing for, diagnosis of and death after severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection across 3 settings (residents of long-term care homes, people living in shelters and the rest of the population).

Methods: We conducted a population-based prospective cohort study involving individuals tested for SARS-CoV-2 in the Greater Toronto Area between Jan. 23, 2020, and May 20, 2020. We sourced person-level data from COVID-19 surveillance and reporting systems in Ontario. We calculated cumulatively diagnosed cases per capita, proportion tested, proportion tested positive and case-fatality proportion for each setting. We estimated the age- and sex-adjusted rate ratios associated with setting for test positivity and case fatality using quasi-Poisson regression.

Results: Over the study period, a total of 173,092 individuals were tested for and 16,490 individuals were diagnosed with SARS-CoV-2 infection. We observed a shift in the proportion of cumulative cases from all cases being related to travel to cases in residents of long-term care homes (20.4% [3368/16,490]), shelters (2.3% [372/16,490]), other congregate settings (20.9% [3446/16,490]) and community settings (35.4% [5834/16,490]), with cumulative travel-related cases at 4.1% (674/16,490). Cumulatively, compared with the rest of the population, the diagnosed cases per capita was 64-fold and 19-fold higher among long-term care home and shelter residents, respectively. By May 20, 2020, 76.3% (21,617/28,316) of long-term care home residents and 2.2% (150,077/6,808,890) of the rest of the population had been tested. After adjusting for age and sex, residents of long-term care homes were 2.4 (95% confidence interval [CI] 2.2–2.7) times more likely to test positive, and those who received a diagnosis of COVID-19 were 1.4-fold (95% CI 1.1–1.8) more likely to die than the rest of the population.

Interpretation: Long-term care homes and shelters had disproportionate diagnosed cases per capita, and residents of long-term care homes diagnosed with COVID-19 had higher case fatality than the rest of the population. Heterogeneity across micro-epidemics among specific populations and settings may reflect underlying heterogeneity in transmission risks, necessitating setting-specific COVID-19 prevention and mitigation strategies.

Competing interests: None declared.

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quantifying heterogeneity in “what has happened,” a process often referred to as an epidemic appraisal.16,17

As a first step to support epidemic appraisal, we aimed to characterize, using the best available data sources, patterns over time in testing (proportion tested), diagnoses (diagnosed cases per capita, testing positivity) and outcome (death) after severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection in the GTA across 3 settings for which we have data on the population size: residents of long-term care homes, people using shelters and the rest of the population.

Methods

Study design and setting
We conducted a population-based prospective cohort study of all individuals tested for SARS-CoV-2 infection in the GTA between Jan. 23, 2020, and May 20, 2020. We defined the GTA as the City of Toronto, York, Peel, Halton and Durham public health units.9,18–21

Data sources
We sourced COVID-19 surveillance and laboratory reporting systems, and used person-level data on laboratory-confirmed cases,2 testing and results,22 and death.2

The integrated Public Health Information System (iPHIS) is Ontario’s reportable diseases system.2 Each public health unit submits person-level data to iPHIS, including the date of case report to public health units (case report date); outcomes (e.g., death); case acquisition; demographic characteristics (e.g., sex and age);2 and an outbreak identification number to identify cases related to an outbreak in a specific setting, including long-term care homes and homeless shelters.23,24 Each case was counted once and classified by setting at time of case report.

For testing and positivity data, laboratory and health administrative data sets were linked using unique encoded identifiers and analyzed at ICES.25 Ontario Laboratories Information System (OLIS) contains SARS-CoV-2 infection test data submitted from hospitals, commercial laboratories, the provincial public health laboratory and COVID-19 assessment centres.25 OLIS includes test-episode-level (date, result) and person-level (sex, age, address) data. Patient addresses were used to classify cases in the GTA and residents of long-term care homes. Individuals with a record of emergency department visit or hospital admission in the past year and with a “homelessness” indicator at the time of the service (via linkage to health administrative data) were identified as people experiencing homelessness.26

We estimated the population size of long-term care home residents using the total long-term care home bed capacity in the GTA, assuming complete occupancy.8,27 Population denominators for people using shelters were sourced from public reports28–34 (Appendix 1, available at www.cmajopen.ca/content/8/4/E627/suppl/DC1). For the rest of the population, we subtracted the above estimates from census-derived GTA population size.1 Thus, the rest of the population includes individuals from other congregate facilities (e.g., retirement homes and jails), and we assumed group-specific population sizes were mutually exclusive and static.

Study period and outcomes
iPHIS data obtained through May 31, 2020 (data cut-off date) were used in our analyses for outcomes including diagnosed cases per capita and case-fatality proportions by case report date. OLIS data obtained through May 27 were used in our analyses for outcomes including proportion of individuals who were tested and proportion of individuals tested positive by testing date.

We defined our study period as confirmed cases reported from Jan. 23, 2020, to May 20, 2020, representing about 4 months since the first confirmed case in the GTA.2 However, we used follow-up data up to May 31, 2020, to minimize potential biases from delays in completing outcomes and reporting. By the end of follow-up (May 31, 2020), less than 5% (4.3%) of confirmed cases had an unknown outcome (neither died nor resolved, influence of lost to follow-up shown in Appendix 2, Supplementary Table 1, available at www.cmajopen.ca/content/8/4/E627/suppl/DC1). Complete entry of confirmed cases into iPHIS for a given case report date occurs within 3 days.16,17 and thus we assumed complete entry by May 31, 2020, of all cases reported by May 20, 2020. We used the May 27, 2020, OLIS data cut-off date to analyze results of tests sampled by May 20, 2020, because 95% of laboratory results were finalized and reported into OLIS within 6 days of a given testing date.22

Statistical analysis
To examine the completeness of testing data and the accuracy of classification by setting in OLIS, we compared the cumulative cases overall and by setting between OLIS and iPHIS.

We calculated the cumulative and daily number, and proportion of diagnosed cases over time in mutually exclusive categories in iPHIS: congregate settings (long-term care home residents, staff or other [e.g., volunteers], shelters and other congregate outbreak settings [hospitals, correctional facilities, retirement homes, group homes and others not yet classified, such as workplaces]; travel related; and community settings (with v. without epidemiological link). Cases with missing information on setting excluded congregate settings.

We calculated the following measures over time in the 3 settings for which we had data on the population size (long-term care home residents, people using shelters and the rest of the population): cumulative diagnoses per capita, cumulative proportion of population tested, daily and cumulative proportion of individuals who tested positive and the cumulative case-fatality proportion. For the case-fatality proportion over time, a rolling average of 7 days was computed using the centre method.18

We examined the age and sex distributions of diagnoses, proportion tested and death across the 3 settings. We used quasi-Poisson regression models19,40 to estimate test positivity rate ratio and case-fatality rate ratio with 95% confidence intervals (CIs) among long-term care home residents and people using shelters, separately, compared with the rest of the population, and adjusting for age (< 50, 50–59, 60–69,
70–79 and ≥ 80 yr) and sex. Finally, as most residents of long-
term care homes were aged 60 years and older, we compared
the age- and sex-specific relative ratios of case-fatality propor-
tion and the proportion who tested positive between long-
term care home residents and the rest of the population,41,42
restricted to people aged 60 years and older.
We used R version 4.0.243 for data cleaning and analyses.

**Ethics approval**
The University of Toronto Health Sciences Research Ethics
Board (protocol no. 39253) approved the study.

**Results**
During the study period (Jan. 23 to May 20, 2020), a total of
173 092 individuals were tested for and 16 490 individuals
were diagnosed with SARS-CoV-2 infection in the GTA
overall, based on OLIS and iPHIS data, respectively
(Table 1).

**Data quality**
OLIS identified 92.0% (15 149/16 490) of confirmed cases in
all settings combined, 97.1% (3269/3368) of confirmed cases

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### Table 1 (part 1 of 2): Comparison across outbreak settings in the Greater Toronto Area in the cumulative risk of diagnosis, testing and case fatality of SARS-CoV-2 infection, as of May 20, 2020

<table>
<thead>
<tr>
<th>Measure</th>
<th>LTCH residents</th>
<th>People using shelters</th>
<th>The rest of the population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population size*</td>
<td>28 316</td>
<td>10 588</td>
<td>6 808 890</td>
</tr>
<tr>
<td>No. of diagnosed cases, overall†</td>
<td>3368</td>
<td>372</td>
<td>12 750</td>
</tr>
<tr>
<td>Sex, female, no. (%)‡</td>
<td>2164 (66.5)§§</td>
<td>159 (43.2)§§</td>
<td>6827 (53.9)§§</td>
</tr>
<tr>
<td>Age, yr, no. (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 50</td>
<td>20 (0.6)</td>
<td>270 (72.6)</td>
<td>6548 (51.4)</td>
</tr>
<tr>
<td>50–59</td>
<td>48 (1.4)</td>
<td>61 (16.4)</td>
<td>2712 (21.3)</td>
</tr>
<tr>
<td>60–69</td>
<td>190 (5.6)</td>
<td>23 (6.2)</td>
<td>1771 (13.9)</td>
</tr>
<tr>
<td>70–79</td>
<td>592 (17.6)</td>
<td>14 (3.8)</td>
<td>755 (5.9)</td>
</tr>
<tr>
<td>≥ 80</td>
<td>2518 (74.8)</td>
<td>4 (1.1)</td>
<td>964 (7.6)</td>
</tr>
<tr>
<td>No. of individuals tested for SARS-CoV-2 infection, overall§</td>
<td>21 617</td>
<td>NA¶¶</td>
<td>150 077</td>
</tr>
<tr>
<td>Sex, female, no. (%)</td>
<td>14 802 (68.5)</td>
<td>NA¶¶</td>
<td>93 358 (62.2)</td>
</tr>
<tr>
<td>Age, yr, no. (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 50</td>
<td>169 (0.8)</td>
<td>NA¶¶</td>
<td>77 384 (51.6)</td>
</tr>
<tr>
<td>50–59</td>
<td>518 (2.4)</td>
<td>NA¶¶</td>
<td>28 571 (19.0)</td>
</tr>
<tr>
<td>60–69</td>
<td>1593 (7.4)</td>
<td>NA¶¶</td>
<td>18 601 (12.4)</td>
</tr>
<tr>
<td>70–79</td>
<td>3598 (16.6)</td>
<td>NA¶¶</td>
<td>10 256 (6.8)</td>
</tr>
<tr>
<td>≥ 80</td>
<td>15 739 (72.8)</td>
<td>NA¶¶</td>
<td>15 265 (10.2)</td>
</tr>
<tr>
<td>No. of deaths among diagnosed cases, overall†</td>
<td>918</td>
<td>3</td>
<td>516</td>
</tr>
<tr>
<td>Sex, female, no. (%)‡</td>
<td>534 (59.9)</td>
<td>0 (0)</td>
<td>211 (40.9)</td>
</tr>
<tr>
<td>Age, yr, no. (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 50</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>22 (4.3)</td>
</tr>
<tr>
<td>50–59</td>
<td>7 (0.8)</td>
<td>2 (66.7)</td>
<td>41 (7.9)</td>
</tr>
<tr>
<td>60–69</td>
<td>35 (3.8)</td>
<td>0 (0)</td>
<td>87 (16.9)</td>
</tr>
<tr>
<td>70–79</td>
<td>132 (14.4)</td>
<td>1 (33.3)</td>
<td>122 (23.6)</td>
</tr>
<tr>
<td>≥ 80</td>
<td>744 (81.0)</td>
<td>0 (0)</td>
<td>244 (47.3)</td>
</tr>
<tr>
<td>Diagnosed cases per 100 000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absolute value</td>
<td>11 894</td>
<td>3513</td>
<td>187</td>
</tr>
<tr>
<td>Relative value</td>
<td>63.6</td>
<td>18.8</td>
<td>Reference</td>
</tr>
<tr>
<td>Percentage of population tested for SARS-CoV-2 infection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absolute value</td>
<td>76.3</td>
<td>NA¶¶</td>
<td>2.2</td>
</tr>
<tr>
<td>Relative value</td>
<td>34.7</td>
<td>NA¶¶</td>
<td>Reference</td>
</tr>
</tbody>
</table>
in long-term care home residents and 23.9% (89/372) of confirmed cases in people using shelters, considering individuals with only indeterminate results as positive as most individuals who had indeterminate results tested positive at a later date. For individuals with multiple tests, we selected 1 testing episode per individual based on the following hierarchy: i.e., the earliest testing episode where the individual was tested positive, or their earliest episode where the results were indeterminate, or earliest episode where the individual tested negative. We considered individuals with only indeterminate results as positive as most individuals who had indeterminate results tested positive at a later date.

**Estimated using quasi-Poisson regression models, adjusting for age and sex.**

††Partial Wald tests were performed to compare the difference in case-fatality rate and test positivity rate across settings estimated by the quasi-Poisson regression models.

†Partial Wald tests were performed to compare the difference in case-fatality rate and test positivity rate across settings estimated by the quasi-Poisson regression models.

### Table 1: Comparison across outbreak settings in the Greater Toronto Area in the cumulative risk of diagnosis, testing and case fatality of SARS-CoV-2 infection, as of May 20, 2020

<table>
<thead>
<tr>
<th>Measure</th>
<th>LTCH residents</th>
<th>People using shelters</th>
<th>The rest of the population</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Percentage of individuals tested positive†</strong></td>
<td>15.1</td>
<td>NA‡‡</td>
<td>Reference</td>
</tr>
<tr>
<td>Absolute value</td>
<td>1.9</td>
<td>NA‡‡</td>
<td>Reference</td>
</tr>
<tr>
<td>Relative value</td>
<td>2.4 (2.2–2.7)</td>
<td>NA‡‡</td>
<td>Reference</td>
</tr>
<tr>
<td>Age- and sex-adjusted test positivity rate ratio (95% CI)**</td>
<td>&lt; 0.001</td>
<td>NA‡‡</td>
<td>Reference</td>
</tr>
<tr>
<td><strong>Case-fatality proportion††</strong></td>
<td>27.3</td>
<td>0.8</td>
<td>4.0</td>
</tr>
<tr>
<td>Absolute value</td>
<td>6.8</td>
<td>0.2</td>
<td>Reference</td>
</tr>
<tr>
<td>Relative value</td>
<td>1.4 (1.1–1.8)</td>
<td>0.4 (0 – 2.5)</td>
<td>Reference</td>
</tr>
<tr>
<td>Age- and sex-adjusted case-fatality rate ratio (95% CI)**</td>
<td>0.02</td>
<td>0.5</td>
<td>Reference</td>
</tr>
</tbody>
</table>

| Note: CI = confidence interval, GTA = Greater Toronto Area, LTCH = long-term care home, NA = not available, OLIS = Ontario Laboratory Information System, SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2. | | | |

*The population size of LTCH residents was approximated by the total LTCH bed capacity in the GTA; the population size of people using shelters was approximated by the estimated number of people experiencing homelessness in the GTA (Appendix 1, available at www.cmajopen.ca/content/8/4/1627/suppl/DC1); the population size of the rest of the population was estimated by the total census population size of the GTA (6,847,794) subtracting the population size of LTCH residents and people using shelters.

†Number of diagnosed cases and number of deaths were sourced from the Integrated Public Health Information System.

‡Of 16,490 diagnosed cases, 112 LTCH residents, 4 people using shelters and 85 individuals from the rest of the population had unknown sex; of 918 deaths, 27 LTCH residents who died had unknown sex; sex distribution proportions are based on nonmissing information.

§We did not show results pertaining to testing for people using shelters owing to low sensitivity in identifying people using shelters in the OLIS testing data. A total of 1398 individuals had an indication of “homelessness” in OLIS data and had at least 1 test for SARS-CoV-2 infection, comprising 13.2% of people using shelters in the GTA. Of these 1398 individuals who may use shelters, 6.4% tested positive, comprising 24% of all diagnosed cases of SARS-CoV-2 infection in shelters by May 20, 2020.

¶We did not report results on testing for this group.

## Distribution in diagnoses over time across settings

During the study period (Jan. 23 to May 20, 2020), there were 16,490 diagnosed cases (241 cases per 100,000 population) in the GTA overall (Table 1, Figure 1A), with 3,368 diagnosed cases among residents of long-term care homes and 372 among people using shelters (Figure 1B). Diagnosed cases with a known travel history accounted for all cases by Feb. 27 among people using shelters (Figure 1B). Diagnosed cases among residents of long-term care homes, followed in April.

By May 20, 43.6% (7,186/16,490) of cumulative cases were diagnosed in congregate settings, and 56.4% (9,304/16,490) were diagnosed outside congregate settings, including 4.1% (674/16,490) travel related, 33.4% (5,834/16,490) in community settings (17.9% [2,945/16,490] with or 17.5% [2,889/16,490] without an epidemiologic link or close contact), and 17.0% (2,796/16,490) with missing information (Figure 1C; Appendix 2, Supplementary Table 2). Of all cases in congregate settings by May 20, 46.9% (3,368/7,186) were among residents of long-term care homes, 5.2% (372/7,186) were among people using shelters, and 47.9% (3,446/7,186) were among other congregate settings (Appendix 3, Supplementary Figure 2).

In March, diagnoses transitioned from predominantly travel-related cases to cases in community settings. By the end of March, 28.5% (505/1775) of cumulative cases were related to travel, 48.6% (863/1775) were in community settings and 10.3% (183/1775) were in congregate settings (Figure 1C). A sharp increase in cases in congregate settings, particularly among residents of long-term care homes, followed in April. From Apr. 1 to Apr. 20, the proportion of cumulative cases increased in each congregate setting: long-term care home residents (from 4.1% [83/1775] to 23.3% [1976/8476]), long-term care home staff (from 2.8% [56/1775] to 5.7% [482/8476]), people using shelters (from 0.0% [0/1775] to 2.4% [201/8476]) and other congregate settings (from 4.0% [81/1775] to 10.9% [923/8476]). The cumulative proportion of cases in congregate settings remained relatively stable thereafter (Figure 1C).
Figure 1: The (A) total number, (B) number of diagnosed cases by setting and (C) distribution of cumulative diagnosed coronavirus disease 2019 cases in the Greater Toronto Area (GTA) by setting over time. Settings are defined as mutually exclusive categories by the order shown in the graph (C, from top to bottom) in the event of multiple exposures. “LTCH — other” may include volunteers; “other congregate settings” includes hospitals, correctional facilities, retirement homes, group homes and other not yet classified, such as workplaces; the “information missing” category excludes congregate settings. The calendar date refers to the date the case was reported to the public health unit. Data source: Integrated Public Health Information System. Note: LTCH = long-term care homes.
Cumulative diagnoses per capita by setting

Figure 2 shows the cumulative diagnoses per capita by setting over time. Cumulative diagnoses per capita were 64-fold higher among long-term care home residents and 19-fold higher among people using shelters than those of the rest of the population (Table 1).

Per capita testing volume and positivity rate

By May 20, 76.3% (21 617/28 316) of residents in long-term care homes had been tested at least once, compared with 2.2% (150 077/6 808 890) of the rest of the population (Table 1). Appendix 3, Supplementary Figure 3 shows the proportions tested by setting over time. The cumulative proportion of individuals who tested positive was 15.1% (3269/21 617, long-term care home residents) and 7.9% (11 791/150 077, rest of the population). Among those tested, the age- and sex-adjusted test positivity rate ratio was 2.4 (95% CI 2.2–2.7) among residents of long-term care homes compared with the rest of the population (Table 1); and the age- and sex-specific test positivity rate ratios ranged from 1.9 to 2.9 (Appendix 2, Supplementary Table 3).

Test positivity of long-term care home residents changed over time with varying testing volume (Figure 3): the daily new testing positivity proportion spiked in early April, with 20%–60% of long-term care home residents testing positive each day. After Apr. 20, and as per capita testing volumes rose, test positivity among residents of long-term care homes fell to around 10%, similar to positivity in the rest of the population (Figure 3B).

Case-fatality proportion

Among cases reported by May 20, 918 residents of long-term care homes, 3 people using shelters and 516 from the rest of the population had died, reflecting a case-fatality proportion of 27.3% (918/3368), 0.8% (3/372) and 4.0% (516/12 750), respectively (Table 1). The age- and sex-adjusted case-fatality proportion among long-term care home residents was 2.4 times higher than among the rest of the population (Table 1).

Figure 2: (A) Comparison of cumulative diagnosed cases per capita over time by outbreak setting in the Greater Toronto Area (GTA). (B) Shows the same information as (A) but with a different Y-axis range. The calendar date refers to the date the case was reported to the public health unit. Data source: Integrated Public Health Information System. Note: LTCH = long-term care homes.
Figure 3: Cumulative (A) and daily (B) number of individuals tested for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection and the proportion of individuals tested positive over time by outbreak setting in the Greater Toronto Area (GTA). The calendar date refers to the date when the specimen was collected. The rest of the population excludes long-term care home (LTCH) residents and people using shelters (defined as individuals who had an indication of “homelessness” in Ontario Laboratories Information System [OLIS]). For individuals with multiple tests, we selected 1 testing episode per individual based on the following hierarchy: the earliest testing episode where the individual was confirmed positive for SARS-CoV-2 infection, or their earliest episode where the results were indeterminate, or earliest episode where the individual tested negative.22 We considered individuals with only indeterminate results as positive as most individuals who had indeterminate results tested positive at a later date. Data source: OLIS.
rate was 1.4 (95% CI 1.1–1.8) times higher among long-term care home residents than among the rest of the population (Table 1), and the age- and sex-specific case-fatality rate ratios ranged from 1.2 to 7.6 (Appendix 2, Supplementary Table 3). The case-fatality proportion remained relatively stable over time from Apr. 15 onward for all settings (Appendix 3, Supplementary Figure 4).

**Interpretation**

We observed a shift in the proportion of cumulative cases of COVID-19 in the GTA from travel-related cases to cases in long-term care home residents, shelters, other congregate settings and community settings. Long-term care homes and shelters had disproportionate per capita diagnosed cases and, in the context of long-term care home residents, higher case fatality among those diagnosed.

The time-course of the microepidemics raise questions about how transmission may have moved through physical (and thus social) networks defined along intersections of architectural, occupation and socioeconomic factors. By Mar. 14, 2020, long-term care homes had restricted visitations, and thus connections between residents and the wider community were largely limited to long-term care home staff and volunteers. Efforts in early March to implement enhanced infection control practices, screening, triage and a temporary housing strategy for people experiencing homelessness and who were awaiting test results may have delayed the onset of outbreaks in shelters. Some community cases may reflect close contacts or an epidemiological link with congregate settings, for example, members of households of people who work or volunteer in facilities. Thus, alongside fewer contacts outside of households in the community, the epidemic may have concentrated in congregate settings and in community households, with additional work needed to discern connections between networks.

The size and trajectory in per capita diagnoses among long-term care home residents and among people using shelters likely reflect underlying differences in testing and differential risk. Early testing in Ontario focused on symptomatic individuals with travel history or who had close contact with a confirmed case. By Mar. 27, symptomatic individuals in several risk groups, including residents of long-term care homes, were prioritized for testing, and after Apr. 15, this included shelters. Long-term care home testing was further expanded on Apr. 8 to include asymptomatic individuals with potential exposures (close contacts) or in shared rooms with a symptomatic resident. The changing testing criteria corresponded to the observed patterns of surge in cases identified in long-term care homes and shelters in April. After Apr. 21, Ontario began to proactively test every (including asymptomatic) resident and staff member in the long-term care home, which may partially explain the subsequent decline in long-term care home residents’ test positivity proportions.

The 2.4-fold higher cumulative test positivity among long-term care home residents after adjustment for age and sex, despite wider scope of testing, suggests higher risk transmission environments and may actually be an underestimate of test positivity difference. Testing criteria outside the context of congregate settings were more risk-based (symptoms, epidemiological link, or close contact or exposures) during our study period. Thus, if risk-based testing yields higher test positivity proportion than population-based testing, and if everyone had been tested in both groups, we would have expected an even higher test positivity ratio among long-term care home residents versus the rest of the population. Similarly, the wider scope of testing for long-term care home residents could lead to a larger proportion of diagnoses of people with infection. Therefore, the infection-fatality rate ratio may be even higher than the 1.4 times case-fatality rate observed in the current study between long-term care home residents and the rest of the population.

The higher age- and sex-adjusted case-fatality rate among long-term care home residents as compared with the rest of the population may reflect underlying differences in comorbidities associated with COVID-19- attributable mortality or goals of care. Future studies including information on comorbidities could help identify causal pathways between residing in long-term care homes and increased case-fatality rate.

**Limitations**

Our analyses were limited to subpopulations on whom population size denominators were available (e.g., we could not estimate diagnoses per capita for long-term care home staff and for retirement homes). Future work in epidemic appraisal necessitates population size and per capita estimates across each type of outbreak setting and across additional sociodemographic and occupational disaggregation, as these data are now being collected. For example, occupation data will help distinguish staff cases in the shelter setting. The “rest of the population” subsampled other congregate facilities, and thus our estimates of the relative difference in per capita testing and positivity may be an underestimate, as other facilities (e.g., hospitals) were associated with more testing and risk of outbreaks. Even in a 4-month period, shifts may be possible in setting-specific population size. We could not estimate testing per capita or test positivity proportion among people using shelters given low sensitivity in identifying this population in the testing data. However, our data suggest that a minimum of 13.2% of people using shelters had been tested by May 20, 2020 (Appendix 3, Supplementary Figure 1C), suggesting that higher diagnoses per capita among people using shelters may be partially explained by increased testing. Work is underway to improve the sensitivity of algorithms to identify people experiencing homelessness. Our case-fatality estimates could be underestimated, as 4.3% of cases had an unknown outcome by the end of follow-up. Finally, test positivity and case-fatality proportions are limited to individuals with at least 1 test and thus may not generalize to those never tested, who may have lower test positivity and case-fatality proportions.

**Conclusion**

Long-term care homes and shelters had disproportionate diagnosed cases per capita, and residents of long-term care homes diagnosed with COVID-19 had higher case fatality than the rest of the population. Heterogeneity across microepidemics signal
the need for setting- and population-specific strategies in the next phase of the public health response in Canada, which could be guided by modelling the risks of onward transmission across each layer of heterogeneity and connections between networks.

References


63. E627/suppl/DC1.