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Characteristics of COVID-19 in Homeless Shelters

A Community-Based Surveillance Study

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Background: Homeless shelters are a high-risk setting for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) transmission because of crowding and shared hygiene facilities.

Objective: To investigate SARS-CoV-2 case counts across several adult and family homeless shelters in a major metropolitan area.

Design: Cross-sectional, community-based surveillance study. (ClinicalTrials.gov: NCT04141917)

Setting: 14 homeless shelters in King County, Washington.

Participants: A total of 1434 study encounters were done in shelter residents and staff, regardless of symptoms.

Intervention: 2 strategies were used for SARS-CoV-2 testing: routine surveillance and contact tracing ("surge testing") events.

Measurements: The primary outcome measure was test positivity rate of SARS-CoV-2 infection at shelters, determined by dividing the number of positive cases by the total number of participant encounters, regardless of symptoms. Sociodemographic, clinical, and virologic variables were assessed as correlates of viral positivity.

Results: Among 1434 encounters, 29 (2% [95% CI, 1.4% to 2.9%]) cases of SARS-CoV-2 infection were detected across 5 shelters. Most (n = 21 [72.4%]) were detected during surge testing events rather than routine surveillance, and most (n = 21 [72.4% {CI, 52.8% to 87.3%}]) were asymptomatic at the time of sample collection. Persons who were positive for SARS-CoV-2 were more frequently aged 60 years or older than those without SARS-CoV-2 (44.8% vs. 15.9%). Eighty-six percent of persons with positive test results slept in a communal space rather than in a private or shared room.

Limitation: Selection bias due to voluntary participation and a relatively small case count.

Conclusion: Active surveillance and surge testing were used to detect multiple cases of asymptomatic and symptomatic SARS-CoV-2 infection in homeless shelters. The findings suggest an unmet need for routine viral testing outside of clinical settings for homeless populations.

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For author, article, and disclosure information, see end of text.
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* For members of the Seattle Flu Study Investigators, see the **Appendix** (available at Annals.org).

More than 560 000 persons in the United States are homeless (1). This population has disproportionately higher morbidity and mortality rates than the general population because of respiratory pathogens (2–4). Homeless populations in shelter settings may be at elevated risk for outbreaks because of overcrowding and shared hygiene facilities (5, 6). While the coronavirus disease 2019 (COVID-19) pandemic in the United States places a substantial burden on existing public health infrastructure, there are additional concerns for homeless populations, who may face challenges accessing testing services and clinical care (7–9).

Community-based surveillance studies can characterize the burden of emerging pathogens, especially in hard-to-reach populations. Most respiratory virus studies of homeless populations have relied on point-in-time, cross-sectional sampling of relatively small numbers of persons (3, 10, 11). Studies of the COVID-19 pandemic in homeless shelters thus far have focused on case series or single outbreaks with limited data collected (12, 13). In this study, we investigated the frequency of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection detected through active surveillance in a community-based, cross-sectional study of acute respiratory illness (ARI). We describe the test positivity rate, demographic characteristics, and related clinical and virologic factors of SARS-CoV-2 infection in diverse homeless shelters in King County, Washington.

See also:

Web-Only
Supplement

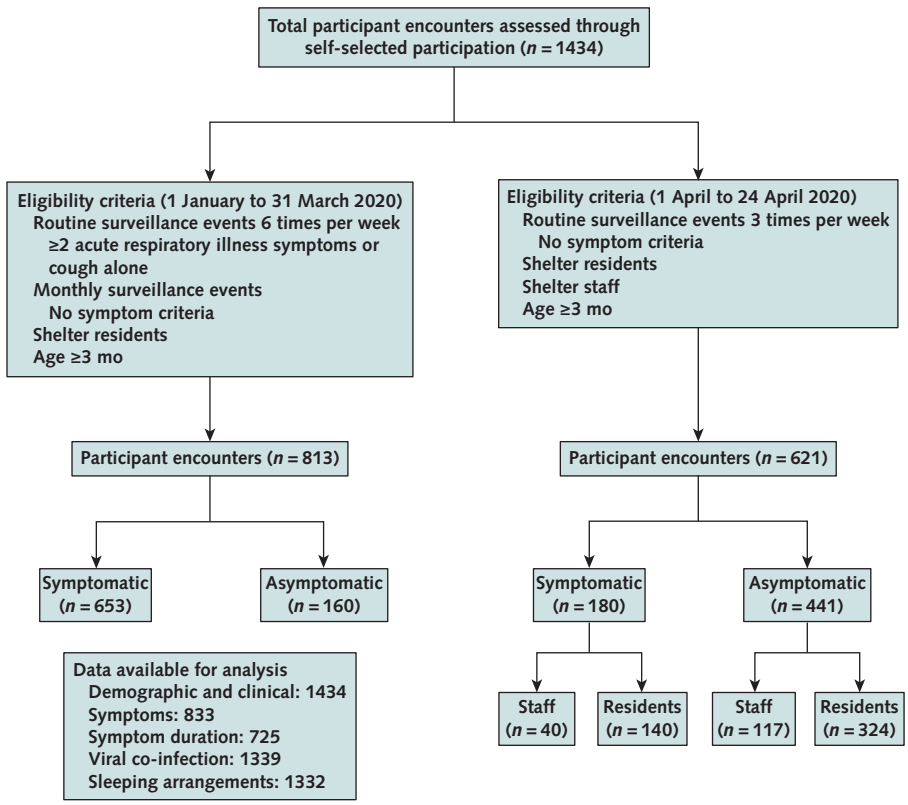
METHODS

Design Overview and Study Population

We did a cross-sectional surveillance study of SARS-CoV-2 cases in homeless shelters in a major metropolitan area. This was a substudy of a multiyear, cluster randomized trial of onsite testing and treatment of influenza at homeless shelters initiated in November 2019.

Study recruitment visits occurring between 1 January and 24 April 2020 were included in this analysis. Between 1 January and 31 March 2020, persons experiencing homelessness who met the following criteria were eligible for participation: aged 3 months or older, identified their primary residence as 1 of 9 participating

Figure 1. Study flow diagram.



Symptomatic encounters include those with ≥1 self-reported symptom.

shelters, and self-reported new or worsening cough alone or 2 or more new or worsening ARI symptoms with onset in the past 7 days. Eligible ARI symptoms included subjective fever, cough, sore throat, shortness of breath, myalgia, headache, and rhinorrhea. Data on chills, sweats, ear pain or discharge, nausea or vomiting, diarrhea, and rash were also collected, although these alone were not sufficient to meet ARI criteria. Once a month, study eligibility was extended to shelter residents aged 3 months or older regardless of symptoms. Study staff recruited participants 6 days a week during this period (Figure 1).

In response to SARS-CoV-2 in Washington State, onsite testing and treatment of influenza (that is, the trial intervention) were discontinued on 1 April 2020. We reduced study staff to 3 onsite days per week at each shelter and recruited persons regardless of symptoms. Shelter staff were also eligible for study participation at this time.

Individual participants were not followed longitudinally, but eligible persons could have multiple encounters throughout the study period. Study participation was limited to once weekly unless new or worsening ARI symptoms developed, in which case a person was permitted to reenroll within 7 days. This study was approved by the Human Subjects Division of the University of Washington Institutional Review Board (STUDY00007800).

Study Setting and Sampling Strategy

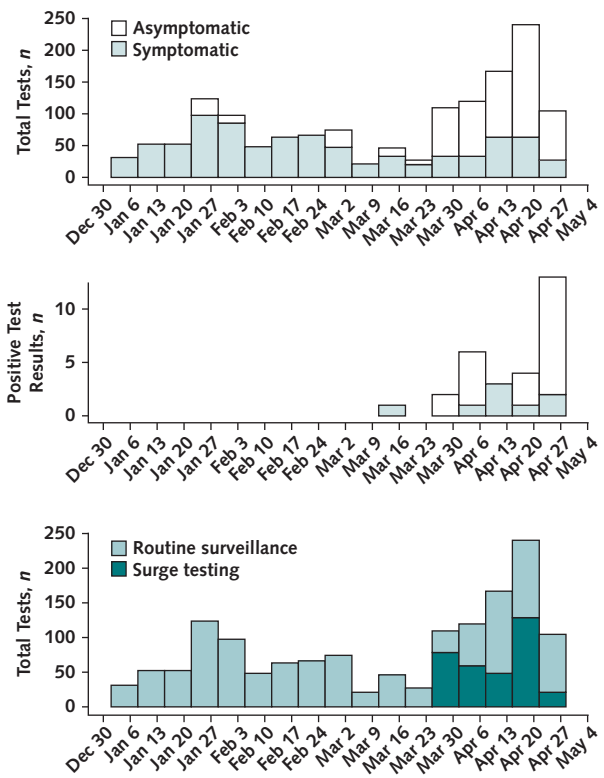
Participants were recruited in person using 2 mechanisms: routine surveillance and surge testing events. Routine surveillance, as detailed earlier, involved self-selected participation at staffed kiosks in shelters during standardized days and times. Surge testing was initiated on 30 March 2020 (and continued through 24 April) in collaboration with Public Health–Seattle & King County's Communicable Disease Epidemiology Team to conduct contact tracing at 6 shelters where cases of SARS-CoV-2 were previously detected (Figure 2). During these 1-day events, we offered SARS-CoV-2 testing to all residents and staff. In addition to 3 shelters participating in routine surveillance, we did surge testing at 3 other shelters where a case of SARS-CoV-2 was detected. These 3 additional shelters had residents or staff members that had sought services from or worked at 1 of the routine surveillance sites in the prior month. Sampling strategies for asymptomatic versus symptomatic study participants were the same at these sites.

The 9 original participating shelters included those serving women (shelter A), mixed-sex adults (shelters B and C), mixed-sex adults aged 18 to 25 years (shelter D), families (shelters E, F, and G), men aged 50 years or older (shelter H), and men aged 18 years or older (shelter I). Private or shared rooms were available as sleeping accommodations at shelters E, F, and G. Shelters B

and G were closed in early April, and to reduce crowding, residents were moved to shelters J and K, which had private or shared rooms. We did routine surveillance at these new sites. Altogether, 11 shelters (shelters A through K) were sites for routine surveillance, and 3 additional shelters (shelters L, M, and N) were sites for surge testing alone. Maximum nightly capacity ranged from 45 to 275 persons. **Supplement Table 1** (available at Annals.org) shows shelter site characteristics and participant encounter metrics.

All questionnaire data were collected electronically in Research Electronic Data Capture (REDCap) on a tablet (**Supplement**, available at Annals.org). Participants chose to complete the questionnaire themselves or with the assistance of study staff. Telephonic interpretation services were available for non–English-speaking participants. Mid-nasal samples were obtained using a sterile nylon flocked nasal swab (Copan Diagnostics). Until 6 March, study staff collected these swabs. Thereafter, because of heightened infection control precautions, participants were instructed to self-collect a mid-nasal swab while observed by study staff. Visual guides were shared with participants before sample collection to demonstrate self-swabbing.

Figure 2. Count of SARS-CoV-2 cases and total participant encounters by week, disaggregated by symptom status and sampling strategy, from 1 January to 24 April 2020.



Symptomatic encounters include those with ≥1 self-reported symptom. SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2.

Variables

Questionnaire data included participant age, race, sex, smoking status, underlying conditions, flu vaccine status, sleeping arrangements, and symptom profiles and duration. Smoking status was determined by asking participants if they used tobacco products, e-cigarettes, or vape pens. Underlying conditions included asthma, blood disorders, cancer, chronic obstructive pulmonary disease or emphysema, chronic bronchitis, immunosuppression, liver disease, heart disease, diabetes, neurologic conditions, or aspirin therapy. Flu vaccine status was determined by self-reported receipt of influenza vaccine since 1 July 2019. Sleeping arrangements were reported only by shelter residents and categorized as communal or private room/shared family room. Communal included sleeping in a congregate space with bunk beds, bed mats, or rooms shared with more than 1 family.

Participant encounters with 1 or more new or worsening symptoms with onset in the past 7 days were defined as symptomatic, and those without any new or worsening symptoms in the past 7 days were defined as asymptomatic. Participants with ARI symptoms also had symptom duration data collected in response to the question, "When did the symptoms you mentioned in the beginning of this survey become new or worsening?" Viral co-infection was defined as the presence of 2 or more viral pathogens (**Supplement Table 2**, available at Annals.org). Influenza-like illness was defined as having a fever and cough or sore throat. Coronavirus disease 2019–like illness was defined as fever and cough or increased difficulty breathing.

SARS-CoV-2 Testing

Samples were transported to the University of Washington laboratory in Universal Viral Transport Medium (Becton Dickinson) in ice-packed coolers and stored at 4 °C before testing. Testing was done at the Brotman Baty Institute for Precision Medicine. Total nucleic acids were extracted (MagNA Pure [Roche]) and tested for the presence of 27 respiratory pathogens using TaqMan reverse transcriptase polymerase chain reaction (RT-PCR) on the OpenArray platform (Thermo Fisher Scientific) as well as SARS-CoV-2 using a laboratory-developed test or research assay (**Supplement Table 2**). For the laboratory-developed test, SARS-CoV-2 detection was done using real-time RT-PCR with probe sets targeting Orf1b and S with FAM fluor (Life Technologies 4332079 assays #APGZJKF and #APXGVC4APX) multiplexed with a ribonuclease P (RNase P) probe set with VIC or HEX fluor (Life Technologies A30064 or IDT custom), each in duplicate on a QuantStudio 6 instrument (Applied Biosystems). The research assay uses only the Orf1b and RNase P multiplexed RT-PCR in duplicate.

Shelter specimens collected between 25 February and 18 March 2020 were tested for SARS-CoV-2 using the research assay in real time. Specimens collected after 19 March were tested for SARS-CoV-2 using the laboratory-developed test under an Emergency Use Authorization issued by Washington State. Specimens collected before 25 February were tested retrospec-

Table 1. Characteristics of Participant Encounters in Shelter Residents and Staff, Overall and by Testing Event Type and SARS-CoV-2 Infection Status

Characteristic	All Participant Encounters (*n* = 1434)	Testing Event Type		SARS-CoV-2 Infection Status	
		Routine Surveillance (*n* = 1119)	Surge Testing (*n* = 315)	Positive (*n* = 29)	Negative (*n* = 1405)
Median age (range), *y*	46 (0–82)	44 (0–81)	55 (0–82)	58 (3–72)	45 (0–82)
Age group, *n* (%)*					
<5 y	50 (3.5)	46 (4.1)	4 (1.3)	1 (3.4)	49 (3.5)
5–17 y	61 (4.3)	53 (4.7)	8 (2.5)	0 (0.0)	61 (4.3)
18–34 y	347 (24.2)	304 (27.2)	43 (13.7)	2 (6.9)	345 (24.5)
35–59 y	737 (51.4)	563 (50.3)	174 (55.2)	13 (44.8)	724 (51.5)
≥60 y	237 (16.5)	153 (13.7)	84 (26.7)	13 (44.8)	224 (15.9)
Male, *n* (%)†	973 (67.9)	709 (63.4)	264 (83.8)	24 (82.8)	949 (67.5)
Race, *n* (%)‡					
Black or African American	437 (30.5)	346 (31.9)	91 (30.2)	9 (31.0)	428 (30.5)
White	586 (40.9)	459 (42.3)	127 (42.2)	13 (44.8)	573 (40.8)
Other§	224 (15.6)	173 (15.9)	51 (16.9)	6 (20.7)	218 (15.5)
Multiracial	139 (9.7)	107 (9.9)	32 (10.6)	0 (0)	139 (9.9)
Hispanic/Latinx‖	186 (13.0)	137 (12.2)	49 (15.6)	5 (17.2)	181 (12.9)
Shelter staff, *n* (%)¶	159 (11.1)	111 (9.9)	48 (15.2)	4 (13.8)	155 (11.0)
Smoker, *n* (%)**	796 (57.7)	625 (58.6)	171 (54.8)	8 (27.6)	788 (58.4)
Underlying condition, *n* (%)††	565 (39.4)	648 (78.0)	221 (70.2)	10 (34.5)	555 (39.5)
Received this season's flu vaccine, *n* (%)‡‡	624 (45.0)	487 (44.9)	137 (45.4)	14 (50.0)	610 (44.9)
Sleeping arrangement in past 7 d, *n* (%)§§					
Communal ‖‖	1044 (78.4)	844 (81.3)	200 (68.0)	24 (85.7)	1020 (78.2)
Private/family room	288 (21.6)	194 (18.7)	94 (32.0)	4 (14.3)	284 (21.7)

SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2.
* Total of 1432 participant encounters.
† Total of 1423 males.
‡ Total of 1386 participant encounters.
§ Included American Indian or Alaska Native, Asian, Native Hawaiian or other Pacific Islander, or another unlisted race.
‖ Total of 1418 participant encounters.
¶ Testing of shelter staff began on 1 April 2020.
** Tobacco or e-cigarette/vape pen use. Total of 1379 participant encounters.
†† Self-reported asthma, blood disorder, cancer, chronic obstructive pulmonary disease/emphysema, chronic bronchitis, immunosuppression, liver disease, heart disease, diabetes, neurologic condition, or aspirin therapy.
‡‡ Total of 1386 participant encounters.
§§ Total of 1332 participant encounters.
‖‖ Includes congregate space with bunk beds, bed mats, or rooms shared with >1 family; excludes shelter staff.

tively using a single replicate Orf1b and RNase P multiplexed RT-PCR research assay to detect SARS-CoV-2 Orf1b.

We used cycle threshold (Ct) values as a semiquantitative measure of viral load in a sample. Cycle threshold values are inversely related to the viral load. Three or 4 replicates for RNase P and SARS-CoV-2 were required to have a Ct value less than 39 for a sample to be considered positive for the laboratory-developed test, and both replicates had to be positive for the research assay.

Outcome

The primary outcome of this study was SARS-CoV-2 infection, defined as detection of SARS-CoV-2 from a nasal swab, regardless of symptoms. We calculated the test positivity rate of SARS-CoV-2 infection at shelters by dividing the number of positive cases by the total number of participant encounters in the study period.

Statistical Analysis

All data in this analysis are presented by participant encounter, defined as each time an eligible person, either with or without symptoms, completed a nasal swab and survey with an onsite study staff member. We used participant encounters as the primary unit of analysis in this study rather than unique participants because of difficulties in matching names at different encounters in a transient population. (We estimated that there were 925 unique participants identified in this study population, but this number is uncertain.) We used descriptive statistics to evaluate the sociodemographic and clinical characteristics, virologic factors, and symptom profiles of all participant encounters. The 95% CIs for study measures of disease occurrence are provided in the Results section. Responses of "Do not know" and "Prefer not to say" were coded as missing observations and dropped from the analysis. Descriptive statistics comparing demographic characteristics of unique participants versus participant encounters were similar overall. Most persons had only 1 encounter during the study period (*n* = 696 [75.2%]), and all SARS-CoV-2 cases included in this study involved unique participants.

Role of the Funding Source

This study was funded by Gates Ventures. The funder was not involved in the design of the study and does not have any ownership over the management and conduct of the study, the data, or the rights to publish.

Table 2. Symptom Profiles and Clinical Characteristics of Participant Encounters, Overall and by SARS-CoV-2 Infection Status

Characteristic	All Participant Encounters (*n* = 1434)	SARS-CoV-2 Infection Status	
		Positive (*n* = 29)	Negative (*n* = 1405)
Mean number of symptoms (SD)	2.0 (2.2)	0.8 (1.6)	2.0 (2.2)
Median number of symptoms (range)	1 (0–9)	0 (0–6)	1 (0–9)
Reported symptoms, *n* (%)			
None	601 (41.9)	21 (72.4)	580 (41.2)
Cough	535 (37.3)	5 (17.2)	530 (37.7)
Rhinorrhea	617 (43.0)	5 (17.2)	612 (43.6)
Subjective fever	231 (16.1)	2 (6.9)	229 (16.3)
Headache	313 (21.8)	1 (3.4)	312 (22.2)
Sore/itchy/scratchy throat	311 (21.7)	3 (10.3)	308 (21.9)
Dyspnea	178 (12.4)	1 (3.4)	177 (12.6)
Myalgia	340 (23.7)	3 (10.3)	339 (24.0)
Fatigue	328 (22.8)	2 (6.9)	326 (23.1)
Ear pain/discharge	49 (3.4)	1 (3.4)	48 (3.4)
Other*	395 (54.6)	3 (50.0)	392 (54.7)
Influenza-like illness, *n* (%)†	190 (13.2)	1 (3.4)	189 (13.4)
COVID-19–like illness, *n* (%)‡	182 (12.7)	1 (3.4)	181 (12.9)
Symptom duration, *n* (%)§			
1–2 d	291 (40.3)	5 (83.3)	286 (39.9)
3–4 d	199 (26.2)	1 (16.7)	188 (26.3)
5–7 d	243 (33.5)	0 (0.0)	243 (33.8)
Co-infection with ≥2 viruses, *n* (%)‖	28 (2.1)	3 (10.3)	25 (1.9)
Streptococcus pneumoniae detection, *n* (%)¶	201 (15.0)	0 (0)	201 (15.0)

COVID-19 = coronavirus disease 2019; SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2.
* Includes chills, sweats, ear pain, nausea/vomiting, diarrhea, or rash. Total of 725 participant encounters.
† Fever and cough or fever and sore throat.
‡ Fever and cough or increased difficulty breathing.
§ Total of 725 participant encounters.
‖ Viruses detected in addition to SARS-CoV-2 included influenza A/B, respiratory syncytial virus, rhinovirus, human metapneumovirus, human coronavirus, human parainfluenza 1 to 4, enterovirus, and bocavirus. Total of 1339 participant encounters.
¶ Total of 1339 participant encounters.

RESULTS

A total of 1434 participant encounters occurred between 1 January and 24 April 2020 at 14 shelters. Of these encounters, 601 (41.9%) involved asymptomatic persons, and 833 (58.1%) involved symptomatic persons.

The median age of participants was 46 years (range, 0 to 82 years) (**Table 1**). Most encounters involved males (67.9%). The predominant racial groups were White (40.9%) and Black or African American (30.5%). More than half of the encounters involved smokers (57.7%), and 39.4% involved participants with at least 1 underlying condition.

Among the 833 symptomatic participant encounters, the mean number of symptoms was 2 (SD, 2.2) (**Table 2**). Rhinorrhea (43.0%), cough (37.3%), and myalgia (23.7%) were the most common symptoms. Of the 725 participant encounters with symptom duration data available, 40.3% had ARI symptoms for less than 2 days at the time of testing. The proportion of encounters that met the case definition for influenza-like illness was 13.2%, and the proportion for COVID-19–like illness was 12.7%. Samples from 28 (2.1%) participant encounters were positive for 2 or more of 17 respiratory pathogens (plus SARS-CoV-2) (**Supplement Table 2**). Samples from 201 (15%) encounters were positive for *Streptococcus pneumoniae*.

We identified 29 (2.0% [95% CI, 1.4% to 2.9%]) participant encounters with SARS-CoV-2 infection involving 29 unique persons. Four (13.8%) of these persons were shelter staff. The positivity rate among encounters with shelter staff compared with shelter residents was similar (2.5% vs. 2.0%, respectively). Approximately half of encounters with SARS-CoV-2 detected involved persons aged 60 years or older (44.8%), and only 3 involved persons younger than 35 years (10.3%) (**Table 1**). Most positive encounters involved males (*n* = 24 [82.8%]) and nonsmokers (*n* = 21 [72.4%]).

Of the 29 encounters with positive SARS-CoV-2 results, 21 (72.4% [CI, 52.8% to 87.3%]) had no symptoms. For positive symptomatic encounters (*n* = 8 [27.6%]), the most frequently reported symptoms were cough and rhinorrhea (*n* = 5 [17.2%] for both) and myalgia and sore throat (*n* = 3 [10.3%] for both). A median of 0 symptoms (range, 0 to 6 symptoms) were reported in encounters positive for SARS-CoV-2 (**Table 2**). One positive encounter met both the influenza-like illness (3.4%) and COVID-19–like illness (3.4%) case definition. Of the 6 positive encounters with symptom duration data available, 5 (83.3%) reported symptoms developing less than 48 hours before study participation. Among encounters that were negative for SARS-CoV-2, 1.9% of persons tested positive for at least 1 other respiratory virus, compared with 10.3% among encounters with positive SARS-CoV-2 results. Mean SARS-CoV-2 Ct values among samples collected from symptomatic (*n* = 8) and asymptomatic (*n* = 21) persons were 27.9 (SD, 5.0) and 29.6 (SD, 6.1), respectively.

In total, participating shelters had 1482 beds, of which 1183 (80.0%) were at routine surveillance sites. A total of 1119 (78%) participant encounters occurred at

routine surveillance sites (Table 1). Shelter H, which served older men, represented the greatest number of participant encounters (18%) from a single site, whereas 21.7% of encounters were in family shelters (Supplement Table 1). Between 30 March and 24 April, we held 8 surge testing events at 6 sites, resulting in 315 participant encounters, ranging from 12 to 97 during each event.

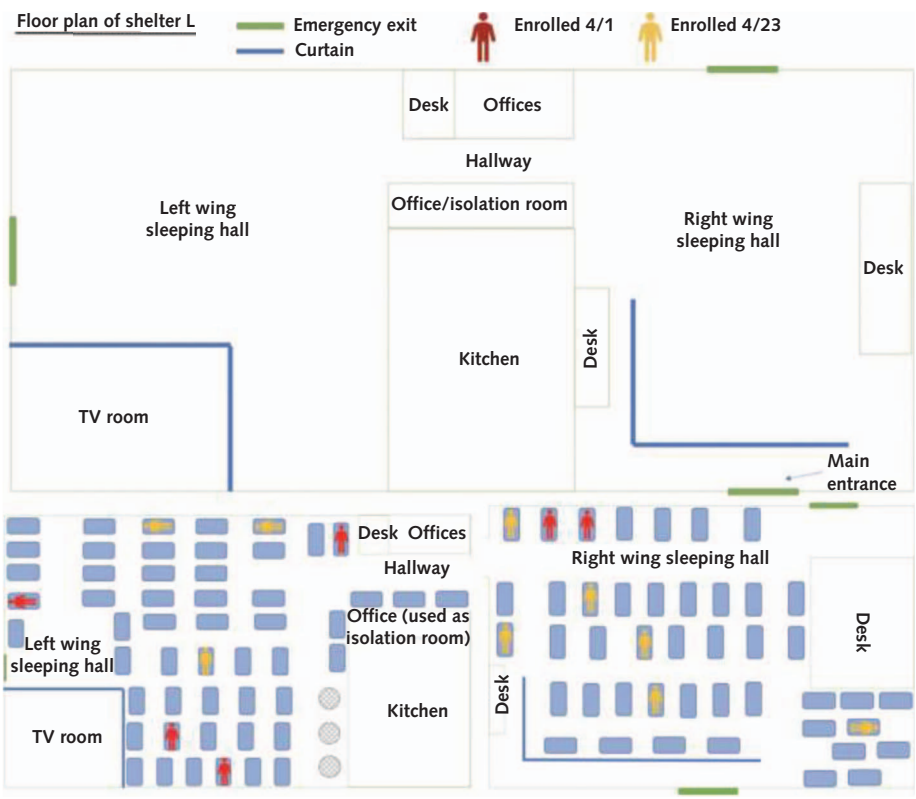
Cases of SARS-CoV-2 were detected at 5 shelters. The first case was detected on 11 March at shelter H, with a subsequent case on 30 March at shelter I (Figure 2). Most positive cases were detected during surge testing events (n = 21 [72.4%]) compared with routine surveillance (n = 8 [27.6%]). Site-specific positivity rates ranged between 1% and 20%. Overall, 85.7% of positive cases were in participants who had slept in a communal space in the past week, compared with 78.2% of negative encounters (Table 1). Of SARS-CoV-2 cases, 5 were detected at shelter F (4.6% of total site encounters), which had both private and communal sleeping spaces. Three SARS-CoV-2 cases from this site were among persons sharing the same private room. The remaining 24 SARS-CoV-2 cases were at shelters serving adult men with only communal sleeping spaces available. Most SARS-CoV-2 cases (79.3%) were detected at shelters serving older male residents, with shared day center services, showering facilities, and a rotating staff (Figure 3).

DISCUSSION

Our findings show detection of SARS-CoV-2 in homeless shelters during 4 months of active surveillance and surge testing. Overall, 2% of participant encounters involved positive SARS-CoV-2 results, with most cases detected through surge testing events. Encounters with positive results were more frequent in older persons and nonsmokers. Most SARS-CoV-2 infections were asymptomatic, with similar mean Ct values in cases with and without symptoms.

In our study, most positive cases reported no or mild symptoms. This may in part be from early detection of presymptomatic cases or identification of persons with mild illness episodes who would not have sought care or testing services. An outbreak investigation at a Boston-based shelter serving only men reported a substantially higher positivity rate (36%) among all residents tested at a single time point. However, testing at this shelter was done at a time when the community incidence of SARS-CoV-2 in Massachusetts was higher than that in Washington State (14, 15). Similar to our study, the Boston group noted that a large proportion of persons with SARS-CoV-2 were asymptomatic, with only 7.5% reporting cough and 1.4% reporting shortness of breath (13). Although the exact role of presymptomatic and asymptomatic SARS-CoV-2

Figure 3. Bed map of 16 SARS-CoV-2 cases detected at shelter L during 2 separate surge testing events on 1 April and 23 April 2020.



Shelter L was a temporary homeless service site opened on 14 March when half of the residents at shelter H were moved to reduce crowding. Residents at shelter H shared day center services, showering facilities, and a rotating staff with shelters G and M during this period. Residents were men aged ≥50 y who slept on communal floor mats in 2 separate rooms. Participant recruitment was done through surge testing only at shelter L; routine surveillance was never available as a sampling mechanism. SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2.

transmission remains unclear, recent publications have linked outbreaks to asymptomatic index cases (16–18).

Recent studies have shown that Ct values from positive RT-qPCR results may relate to viral transmissibility and may inform clinical decision making about isolation precautions (19). Cycle threshold values were similar in persons with and without symptoms, suggesting that viral load may not be associated with symptoms. Prior studies have implicated asymptomatic and presymptomatic persons as a source of infection, but the duration of SARS-CoV-2 infectivity is unknown (16–18). This has major implications for public health and shelter service providers developing guidelines for isolation of residents who are positive for SARS-CoV-2 and reintroduction into a general shelter population. Further research is needed to understand the effect of temporal dynamics in viral shedding on transmissibility of SARS-CoV-2 in communal settings and the role of asymptomatic cases.

Shelter characteristics, particularly resident density and sleeping arrangements, may play a role in SARS-CoV-2 transmission. The outbreak seen in shelters H, L, and M may have been related to the use of floor mats in a communal sleeping space without temporary dividers and less than 6 feet apart (12). We observed only 1 positive SARS-CoV-2 result in shelters with bunk beds rather than floor mats in congregate sleeping areas. The family shelters adhered to the Centers for Disease Control and Prevention recommendations of using curtains as a temporary barrier between familial bed clusters in congregate sleeping areas (20). These shelters also implemented social distancing and handwashing protocols in late March, with daily temperature checks and symptom assessments by staff, which were independent from voluntary participation in this study. These measures may have curtailed further transmission within shelter F. Shelters H, L, and M, where more cases were detected, had limited staff-conducted screening and a shortage of hygiene resources.

We sampled both staff and residents and found SARS-CoV-2 test positivity rates to be similar between the groups. Future analyses will focus on transmission dynamics within shelters, with sampling from both groups.

Our positivity rate was lower than the 8.8% rate seen in the University of Washington clinical laboratory during that same period (21). This may be because most clinical samples were obtained from persons seeking medical care. Public health and other groups did additional testing at 2 shelters in this study during an outbreak investigation between 31 March and 8 April. Interestingly, only 2 of 41 confirmed cases (4.9%) from this investigation were identified through routine symptom-based screening, and only 3 (7.3%) were identified after health care was sought (12). In addition, our study identified nearly a third of SARS-CoV-2 cases through routine surveillance, which may have resulted from study eligibility expansion to asymptomatic persons. We speculate that with earlier asymptomatic testing, additional outbreaks may have been detected at study sites.

This study's findings may be subject to selection bias because all participation was voluntary. High levels of distrust of health care providers and low rates of health care use in homeless populations have been documented (9, 22, 23). This may account for more asymptomatic cases of SARS-CoV-2 having been detected through surge testing events when shelter management actively encouraged all residents and staff to participate. In addition, reducing onsite testing from 6 to 3 days per week may have decreased our ability to detect additional positive cases at participating sites. Another limitation is the lack of robust follow-up data on participants. We had very low response rates to a follow-up survey sent via text message or e-mail to asymptomatic participants 7 days after onsite study participation to evaluate for new or worsening symptoms; thus, it was excluded from our analysis. Therefore, it is unclear what proportion of the asymptomatic SARS-CoV-2 cases detected in this study were presymptomatic. In addition, the small numbers of SARS-CoV-2 cases and unmeasured shelter-level covariates limit the extent to which we can draw conclusions about how sleeping arrangements may mitigate transmission. Finally, this study was not able to track unique participants and could not reliably identify encounters in the same participant.

The sensitivity of self-sampling for SARS-CoV-2 detection may also be a problem. However, a recent study of self-collected mid-turbinate nasal swabs for influenza detection found RNase P in 100% of nasal swab specimens, but with higher mean Ct values among positive results in self-collected swabs compared with clinician-collected nasopharyngeal swabs (24). Additional studies have found that self-swabbing results in viral positivity rates similar to those of sentinel physician networks and has excellent diagnostic yield (25–27).

In conclusion, this study provides key insights into detection strategies for SARS-CoV-2 in a vulnerable, hard-to-reach population. Passive sentinel surveillance for respiratory viruses may only detect symptomatic cases severe enough to prompt health-seeking behavior and may miss milder ones, delaying the recognition of outbreaks and further viral spread (28, 29). Results of this study's combined active surveillance and surge testing strategy suggest an unmet need for routine viral testing outside of clinical settings in homeless shelters and other congregate living facilities.

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