Introduction: The unfolding COVID-19 pandemic has predictably followed the familiar contours of well-established socioeconomic health inequities, exposing and often amplifying preexisting disparities. People living in homeless shelters are at higher risk of infection with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) compared to the general population. The purpose of this study was to identify shelter characteristics that may be associated with higher transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).

Methods: We conducted a cross-sectional assessment of five congregate shelters in Rhode Island. Shelter residents 18 years old and older were tested for SARS-CoV-2 from April 19–April 24, 2020. At time of testing, we collected participant characteristics, symptomatology, and vital signs. Shelter characteristics and infection control strategies were collected through a structured phone questionnaire with shelter administrators.

Results: A total of 299 shelter residents (99%, 299/302) participated. Thirty-five (11.7%) tested positive for SARS-CoV-2. Shelter-level prevalence ranged from zero to 35%. Symptom prevalence did not vary by test result. Shelters with positive cases of SARS-CoV-2 were in more densely populated areas, had more transient resident populations, and instituted fewer physical distancing practices compared to shelters with no cases.

Conclusion: SARS-CoV-2 prevalence varies with shelter characteristics but not individual symptoms. Policies that promote resident stability and physical distancing may help reduce SARS-CoV-2 transmission. Symptom screening alone is insufficient to prevent SARS-CoV-2 transmission. Frequent universal testing and congregate housing alternatives that promote stability may help reduce spread of infection. [West J Emerg Med. 2020;21(5)XX-XX.]
and costly to implement and have unclear benefits. To date, no study has examined the association of shelter characteristics with SARS-CoV-2 outbreaks. In this analysis, we describe the varying prevalence of SARS-CoV-2 infection in five congregate homeless shelters in Rhode Island as well as varying shelter characteristics and infection control practices.

METHODS
We conducted a cross-sectional assessment of congregate shelter residents 18 years of age and older staying in five shelters in Rhode Island, from April 19–April 24, 2020. Testing occurred during the peak of new case identification in Rhode Island. All residents of each shelter were offered testing. At the time of testing, we measured temporal temperature and pulse oximetry and collected information on demographic characteristics, comorbidities (hypertension, diabetes, heart disease, immunosuppression), and viral symptoms. Testing was done at Shelter 5 prior to initiation of temperature and oxygen documentation. Shelter characteristics and infection control practices were assessed by structured telephone interview with shelter administrators. Of note, shelter residents testing positive for SARS-CoV-2 in Rhode Island were being isolated in a hotel with support coordinated by the Rhode Island Department of Health (RIDOH). This screening was performed in collaboration with RIDOH to identify and isolate positive shelter residents.

We collected and managed data using REDCap (Vanderbilt, Nashville, TN). Nasopharyngeal swabbing was done by emergency physicians with training in appropriate nasopharyngeal swab technique. Tests were run on one of three available polymerase chain reaction (PCR) assays: Roche (specificity 99.8%, sensitivity 100%, Basel, Switzerland); Cepheid (specificity 99.2%, sensitivity 95.5%, Sunnyvale, CA); and Abbott (specificity 100%, sensitivity 93%, Chicago, IL).

We used descriptive statistics to summarize participant and shelter characteristics. We compared the proportion of positive SARS-CoV-2 tests among shelters, demographic groups, medical comorbidities, and symptomatology using t-tests and Fisher’s exact tests using STATA (Statacorp, College Station, TX). The analysis was deemed exempt by the RIDOH Institutional Review Board.

RESULTS
Among 302 shelter residents across five shelters, 299 (99.0%) were tested for SARS-CoV-2; one person declined testing, and two declined to have their results included in the analysis. The overall case prevalence across all shelters was 11.7%. Approximately half of shelter residents were White (53%), about one quarter were Latinx (23%), and most were 40-64 years of age (61%, mean age 47.9 years of age) (Tables 1 and 2). More than a third reporting having asthma, chronic obstructive pulmonary disease, hypertension, diabetes, or heart disease (38%), with hypertension being the most prevalent comorbidity (23%) (Table 2). Demographic and shelter characteristics are shown in Table 1.

SARS-CoV-2 prevalence in Shelters 1 and 4 was 21.6% and 35.3%, respectively, while all other shelters had no cases (Table 1). There were no differences in age, gender, or race between people testing positive and negative for SARS-CoV-2 (Table 2). Only 20% of people testing positive (7/35) reported any symptoms; none had fever or hypoxia. There were no differences in the presence of symptoms between people testing positive and negative for SARS-CoV-2 (20.0% vs 14.0%, p = 0.34). People testing positive for SARS-CoV-2 had lower prevalence of comorbidities compared to people testing negative (20% SARS-CoV-2 positive vs 40% SARS-CoV-2 negative, p = 0.02). Among participants with negative tests, 70.1% (185/264) had spent more than two weeks at their shelter, compared to 42.9% (15/35) of participants with positive tests (p<0.001).

Regarding infection control practices, all five shelters required masks, performed daily temperature checks of clients and staff, provided onsite meals, and were open 24 hours (Table 1). Three shelters had stopped accepting new residents for at least two weeks prior to the study and had zero cases at time of testing. The shelter with the highest case positivity rate has several distinct characteristics compared to the other shelters (Table 1). The neighborhood of this shelter had higher census-tract population density compared to the
neighborhoods of the other shelters. The resident population was also found to be more transient than that of other shelters, with only 58% (39/63) reporting staying at the shelter for more than two weeks. This low-threshold shelter has continued to keep its doors open to new residents throughout the pandemic, and given its limited capacity the shelter was unable to arrange sleeping areas at least six feet apart.

**DISCUSSION**

The range of asymptomatic prevalence of SARS-CoV-2 found in different shelters builds on growing data from other cities and has important policy implications. Only one in five people with positive tests were symptomatic, which was not significantly different from those testing negative. Following initial CDC guidance, shelters have relied primarily on symptom screening to control spread of SARS-CoV-2. As this and other recent data have demonstrated, asymptomatic and pre-symptomatic transmission may be the predominant modes of SARS-CoV-2 spread in congregate settings, and thus symptom-guided identification and temperature screening are insufficient strategies to prevent SARS-CoV-2. Sheltering in place, wearing masks, and physical distancing may be at least as effective in preventing transmission as symptom screening.

**Table 1. SARS-CoV-2 prevalence, participant and shelter characteristics, and infection control practices, by homeless shelter.**

|                      | All     | 1       | 2       | 3       | 4       | 5       |
|----------------------|---------|---------|---------|---------|---------|---------|
| Number Tested        | 299     | 51      | 89      | 48      | 68      | 43      |
| SARS-CoV-2 +, n (%)  | 35 (11.7)| 11 (21.6)| 0      | 0      | 24 (35.3)| 0      |
| Age, mean (range)    | 47.9 (18-85)| 43.4 (18-67) | 48.5 (20-72) | 47.8 (25-76) | 46.7 (19-69) | 53.7 (30-85) |
| Female, n (%)        | 59 (20) | 18 (35) | 0       | 32 (67) | 9 (13)  | 0       |
| Race (%)             |         |         |         |         |         |         |
| Black                | 59 (20) | 11 (22) | 17 (19) | 5 (10)  | 17 (25) | 9 (21)  |
| White                | 160 (53)| 18 (36) | 50 (56) | 35 (73) | 36 (53) | 21 (49) |
| American Indian/Alaska Native | 10 (3) | 1 (2) | 3 (3) | 3 (6) | 3 (4) | 0 |
| Other/Unknown        | 70 (23) | 21 (40) | 19 (21) | 5 (10)  | 12 (18) | 13 (30) |
| Latino/a/x, n (%)    |         |         |         |         |         |         |
| Latino/a/x           | 68 (23) | 14 (27) | 15 (17) | 11 (23) | 12 (18) | 16 (37) |
| Non-Latino/a/x       | 213 (71)| 29 (57) | 66 (74) | 37 (77) | 54 (79) | 27 (63) |
| Other/Unknown        | 18 (6)  | 8 (15)  | 8 (9)   | 0       | 2 (3)   | 0       |
| Any comorbidities, n (%) | 113 (38)| 7 (13) | 37 (42) | 30 (63) | 23 (34) | 16 (37) |
| Any symptoms, n (%)  | 44 (15) | 4 (8)   | 7 (8)   | 9 (19)  | 19 (28) | 5 (12)  |
| Census tract population density (number people per square mile) | 10,852 | 2,753 | 10,852 | 21,645 | 2,362 |
| % of beds filled (previous night) | 100 | 88 | 90 | 97 | 100 |
| % of population at shelter >14 days | * | 82 | 96 | 58 | 98 |
| Staff and residents wear masks | Yes | Yes | Yes | Yes | Yes | Yes |
| Daily temperature checks | Yes | Yes | Yes | Yes | Yes | Yes |
| Daily symptom screenings | Daily | 2x Daily | Daily | Daily | 2x daily |
| Onsite meals offered | Yes | Yes | Yes | Yes | Yes | Yes |
| Sleeping spaces 6 feet apart | Yes | No | Yes | No | Yes | Yes |
| Open 24 hours | Yes | Yes | Yes | Yes | Yes | Yes |
| Daily education/updates | No | Yes | No | No | No | No |
| New residents allowed | Yes | No | No | Yes | No | No |

*Data type not collected at this shelter.

SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.
### Table 2. Demographic and clinical characteristics of participants, by SARS-CoV-2 result.

|                | All (N=299) | Positive (N=35) | Negative (N=264) | P-value |
|----------------|-------------|-----------------|------------------|---------|
| **Shelter, n (%)** |             |                 |                  |         |
| 1              | 52 (17)     | 11 (31)         | 40 (15)          |         |
| 2              | 89 (30)     | 0 (0)           | 89 (34)          |         |
| 3              | 48 (16)     | 0 (0)           | 48 (18)          | < 0.001 |
| 4              | 68 (23)     | 24 (69)         | 44 (17)          |         |
| 5              | 43 (14)     | 0 (0)           | 43 (16)          |         |
| **Demographics** |             |                 |                  |         |
| **Age, n (%)**  |             |                 |                  |         |
| 18-39          | 89 (30)     | 9 (25)          | 80 (31)          | 0.83    |
| 40-64          | 184 (61)    | 23 (66)         | 161 (61)         |         |
| >65            | 26 (9)      | 3 (9)           | 23 (8)           |         |
| **Gender, n (%)** |             |                 |                  |         |
| Female         | 59 (20)     | 9 (26)          | 50 (19)          | 0.77    |
| Male           | 238 (80)    | 26 (74)         | 212 (80)         |         |
| Trans/other    | 2 (1)       | 0 (0)           | 2 (1)            |         |
| **Race, n (%)** |             |                 |                  |         |
| Black          | 59 (20)     | 7 (20)          | 52 (20)          |         |
| White          | 160 (53)    | 17 (49)         | 142 (54)         | 0.88    |
| Al/Alaska Native | 10 (3)   | 1 (3)           | 9 (3)            |         |
| Other/Unknown  | 70 (23)     | 10 (29)         | 60 (23)          |         |
| **Latino/a/x, n (%)** |         |                 |                  |         |
| Latino/a/x     | 68 (23)     | 6 (17)          | 62 (23)          |         |
| Non-Latino/a/x | 213 (71)    | 22 (63)         | 191 (73)         | 0.001   |
| Other/Unknown  | 18 (6)      | 7 (20)          | 11 (4)           |         |
| **Transiency, n (%)** |         |                 |                  | < 0.001 |
| >14 days at current shelter | 200 (67) | 15 (43)         | 185 (70)         |         |
| Slept elsewhere | 48 (16) | 6 (17)          | 42 (16)          |         |
| Unknown        | 51 (17)     | 14 (40)         | 37 (14)          |         |
| **Clinical**   |             |                 |                  |         |
| Any comorbidity | 112 (38)  | 7 (20)          | 105 (40)         | 0.02    |
| Asthma/COPD    | 52 (17)     | 1 (3)           | 51 (29)          |         |
| Hypertension   | 68 (23)     | 4 (11)          | 64 (24)          |         |
| Diabetes       | 32 (11)     | 2 (6)           | 30 (11)          |         |
| Heart disease  | 23 (8)      | 2 (6)           | 21 (8)           |         |
| **Temperature, mean (SD)** |         |                 |                  | 0.06    |
| 97.1 (0.05)    | 96.8 (0.86) | 97.2 (0.86)     | 96.7 (0.13)      |         |
| **Oxygen saturation, mean (SD)** |         |                 |                  | 0.59    |
| 96.7 (0.12)    | 97 (0.39)   | 96.7 (0.13)     | 96.7 (0.13)      |         |
| **Symptoms, n (%)** |         |                 |                  | 0.34    |
| Any symptoms   | 44 (14.7)   | 7 (20)          | 37 (14)          |         |
| Fever          | 5 (2)       | 1 (3)           | 4 (2)            |         |
| Cough          | 15 (5)      | 2 (6)           | 13 (5)           |         |
| Shortness of breath | 11 (4) | 0 (0)          | 11 (4)           |         |
| Body aches     | 5 (2)       | 2 (6)           | 3 (1)            |         |
| Nausea, vomiting, or diarrhea | 15 (5) | 2 (6)         | 13 (5)           |         |
| Loss of smell or taste | 9 (3)  | 2 (6)         | 7 (3)            |         |

SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; COPD, chronic obstructive pulmonary disease; SD, standard deviation.
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Varying sensitivities/specificities. This may have impacted during viral shedding. PCR tests used may have a 20-30% false negative rate and are only adequate personal exposures. Our analysis does not account for they work at multiple shelters/organizations or have other staff are also a potential risk to residents, particularly if residents likely dilutes the overall prevalence of positivity. Although this study is the first to assess shelter-level characteristics, it was limited by the cross-sectional design as well as the small number of shelters. First, at the time of our study, many shelter residents who had tested positive were already housed in a local hotel, which likely led to an underestimate of true prevalence of SARS-CoV-2 among people experiencing homelessness. Second, testing done at the shelters with more transient residents only reflects the residents present on the night of testing, not the entire group that intermittently uses shelter services. Those shelters were more likely to have residents test positive; thus, an inability to assess the full complement of those shelters’ residents likely dilutes the overall prevalence of positivity when all shelters are examined in aggregate. Third, shelter staff are also a potential risk to residents, particularly if they work at multiple shelters/organizations or have other personal exposures. Our analysis does not account for potential risk posed by staff. Fourth, PCR tests used may have a 20-30% false negative rate and are only adequate during viral shedding. Furthermore, tests were conducted in three separate labs using different PCR assays with varying sensitivities/specificities. This may have impacted uniformity of test results. Lastly, since this was a cross-sectional analysis we were not able to determine whether the asymptomatic positive cases were actually presymptomatic.

CONCLUSION
A growing body of literature has demonstrated that asymptomatic and presymptomatic spread of SARS-CoV-2 may be significant. The results of this study further underscore that symptom screening and temperature monitoring are insufficient means to mitigate transmission of SARS-CoV-2 in homeless shelters and other congregate settings. Shelter characteristics such as population density, the capacity to maintain population stability, and the ability and resources to implement preventative practices such as physical distancing, may be partially effective in mitigating disease spread. In order to prevent SARS-CoV-2 transmission while continuing to provide essential, accessible services to people experiencing homelessness, there is a need for frequent universal testing, infection control support at homeless shelters, and expanded availability of permanent housing.

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