Annals of Epidemiology 64 (2021) 96–101

Contents lists available at ScienceDirect

Annals of Epidemiology

journal homepage: www.annalsofepidemiology.org

Original article

Comparison of COVID-19 mitigation and decompression strategies among homeless shelters: a prospective cohort study

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A R T I C L E I N F O

Article history:
Received 11 March 2021
Revised 18 July 2021
Accepted 27 August 2021
Available online 10 September 2021

Keywords:
Homeless population
COVID-19
Mitigation strategies
Community intervention
Health disparities

A B S T R A C T

Purpose: To compare the effectiveness of COVID-19 mitigation strategies in two homeless shelters in Massachusetts during the pandemic.
Methods: We conducted a prospective cohort study that followed guests in two Massachusetts homeless shelters between March 30 and May 13, 2020, which adopted different depopulation strategies. One set up temporary tents in its parking lot, while the other decompressed its guests to a gym and a hotel. The outcome was assessed by comparing the odds ratios of positive SARS-CoV-2 RT-PCR assays.
Results: Guests residing at the shelter that used temporary tents had 6.21 times (95% CI = 1.86, 20.77) higher odds of testing positive for SARS-CoV-2 at follow-up after adjusting for loss to follow up, age, gender, and race. The daily COVID-19 symptoms checklist performed poorly in detecting positive infection.
Conclusions: The study highlights the importance of depopulating shelter guests with stable and adequate indoor space to prevent SARS-CoV-2 transmission. Daily temperature and symptom checks should be combined with routine testing. With the rising homelessness due to mass unemployment and eviction crisis, our study supports further governmental assistance in decompressing homeless shelters during this pandemic.

Introduction

Every year, an estimated 1.4 million Americans live in homeless shelters or transitional housing [1]. The congregate living situation in shelters poses a challenge in practicing personal hygiene and social distancing, creating an environment for the rapid transmission of SARS-CoV-2, the virus causing the Coronavirus Disease 2019 (COVID-19), among shelter guests [2]. A study from 19 homeless shelters found an average of 25% SARS-CoV-2 positivity rate [3]. Due to the devastating economic impact of the COVID-19 pandemic, the number of people experiencing homelessness is projected to increase by 40%–45% [4]. The unprecedented increase in people experiencing homelessness makes it even more challenging to protect this vulnerable population. The housing accommo-

Abbreviation: s: ANOVA, Analysis of variance; IPW, Inverse probability weighting; LR, Likelihood Ratio; MSM, Marginal structural model; RT-PCR, Real-time, reverse-transcriptase-PCR; COVID-19, The Coronavirus Disease 2019; FEMA, The Federal Emergency Management Agency; CDC, The U.S. Center for Disease Control and Prevention; HUD, The United States Department of Housing and Urban Development.

Declaration of competing interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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https://doi.org/10.1016/j.annepidem.2021.08.023
1047-2797/

dations and SARS-CoV-2 risk mitigation strategies among this population have become a pressing issue for shelters globally.

The U.S. Center for Disease Control and Prevention (CDC) and the United States Department of Housing and Urban Development (HUD) published several interim guidelines for homeless service providers to protect guests and staff members from COVID-19 [5,6]. However, these guidelines provide limited guidance on the details of overflow and decompression strategies. Local governments have collaborated with shelters and initiated various innovative approaches to house people experiencing homelessness during the pandemic. For example, several cities partnered with school dormitories or hotels to convert these spaces to create overflow, quarantine, or isolation sites for people experiencing homelessness [7,8]. Despite these efforts, many homeless shelters remain packed with guests unable to practice the CDC's social distancing guideline. Additionally, mitigation strategies to reduce SARS-CoV-2 infection risk vary significantly across shelters due to resource availability and limitation. It is unclear which decompression practice yields the best prevention result. Besides, overflow and decompression strategies, several infection control strategies are recommended, [5] including daily symptom screening, surveillance testing, and face covering. Still, there is also a limited understanding of the effectiveness of these strategies.

The present study aims to: 1) compare the effectiveness of different SARS-CoV-2 mitigation and decompression strategies in homeless shelters; 2) illustrate the mitigation challenges for homeless organizations; and 3) provide further recommendations to accommodate people experiencing homelessness during the COVID-19 pandemic.

Material and methods

Study design and study population

This prospective cohort study is reported according to the Strengthening the Reporting of Observational Studies in Epidemiology guidelines [9]. Participants were guests residing in the two homeless shelters in Brockton and Quincy, Massachusetts, between the period of March 30 and May 13, 2020. The two cities recorded their first COVID-19 case and declared a state of emergency during the same period [10,11]. However, the City of Quincy announced a face-covering order on March 20, 2020, which was earlier than the City of Brockton. Brockton introduced a face-covering order on May 6, 2020, following the order signed by the Massachusetts Governor Charlie Baker [12]. On the other hand, there was no shelter-in-place order announced in Massachusetts, and instead the state announced a stay-at-home advisory effective on March 24. Furthermore, the COVID-19 confirmed case incidence up till May 13, 2020, was 126.5 and 100.9 per 10,000 population, respectively, in Plymouth (the county where Brockton City is located) and Norfolk (the county where Quincy City is located) [13].

The two shelters were operated by the same nonprofit organization but adopted different mitigation strategies to reduce or prevent COVID-19 transmission based on available resources. The Quincy shelter site received a $500,000 emergency fund from the city and temporarily expanded its shelter space by renting a recreational center (Location B) and a hotel (Location C) to depopulate its primary location (Location A) [14]. The Quincy shelter first redistributed its guests between Location A and Location B. Guests relocated to Location B were long-term shelter guests with chronic illnesses and no known substance use history or stability on the Medication Assisted Treatment program. Location C was later added to accommodate new guests. In Location A and Location B, beds were spread out at least 6 feet apart per CDC guidelines, and guests were reminded of social distancing at all times in common areas and shared bathrooms. Guests staying in Location C were provided with individual rooms and nonshared bathrooms.

The Brockton shelter site, which is located in a more disadvantaged region with a higher poverty rate compared to Quincy [15,16], erected temporary tents outside in the parking lot of the shelter location during the study period. Guests were distributed between indoor (building) versus outdoor (tent) space according to the needs for cigarette smoking, use of substances, and/or chronic illnesses. For example, guests with needs to access outdoor space on a constant basis were placed in the tent area.

All locations implemented daily symptom screening and temperature checks. Guests that failed to return to the shelter at the cut-off evening time were not allowed re-entry. All guests were encouraged to practice social distancing and face-covering during their stay in the shelters.

IRB approval

The SARS-CoV-2 testing was conducted as part of group testing mandated by the shelters, as a requirement to continue one's stay at the shelter, independent of this research. The existing medical records collected during this study period were deidentified at the primary clinical site before analysis. Therefore, the study received a nonhuman research determination from the Management Sciences for Health (SC-0,012,020) and Boston University (H-40,496).

Measures

The primary outcome of this study is SARS-COV-2 real-time, reverse-transcriptase-PCR (RT-PCR) assays results among shelter guests. A trained provider at Manet Community Health Center or Brockton Neighborhood Health Center performed the swabbing procedure and transferred each specimen to a 3 mL vial with viral transport media. The samples were then transported to Quest Diagnostic laboratory in Marlborough, Massachusetts, for analysis. All sampling, specimen storage, transportation, and testing procedures followed the CDC guidelines [17]. Due to a nationwide swab shortage in March 2020, specimens were collected differently based on guests' shelter location. For guests residing in Quincy Location A, samples were collected from anterior nares (sensitivity 63%) [18]. We collected oropharyngeal samples for Quincy Location B and nasopharyngeal samples for Quincy Location C, with sensitivity 32% [18] and 98.3% [19] based on published studies. All guests at the Brockton shelter site received nasopharyngeal sample collection during the baseline testing period. All participants received nasopharyngeal swabs in the subsequent follow-up testing. Once the testing clinic received a positive RT-PCR assay result, the clinician would inform the shelter representative immediately via phone, who would then place the shelter guest with positive assay result in insolation within the shelter while the staff member coordinated with the State sponsored isolation center. Once a room was confirmed at the isolation center, the shelter would then transport the guest to the center by shelter vehicle with all CDC recommended protocols in place. As guests with a positive assay result at baseline testing were transferred to specific isolation sites, they were therefore excluded from this study.

Pre- and post-testing surveys

Shelter guests in Quincy took two paper-based questionnaires during the baseline and follow-up SARS-CoV-2 testing. We conducted the first survey prior to baseline testing and collected data on respondents' past medical history, COVID-19 related symptoms, frequency and reasons of leaving the shelter during the stay, and SARS-CoV-2-related exposure information (Supplementary Data 1). The second survey, which was conducted post-follow-up testing

Table 1
Comparison of baseline and follow-up SARS-CoV-2 RT-PCR assay results and sociodemographics among homeless shelter guests in Quincy and Brockton during the study period from March to May 2020

	Total shelter guests (n_1 = 318 at baseline test and n_2 = 206 at follow up test) [⊗]	Quincy shelters (n_1 = 131 at baseline test and n_2 = 123 at follow up test) [⊗]	Brockton shelter (n_1 = 187 at baseline test and n_2 = 83 at follow up test) [⊗]	*P*-value
Age, (mean±SD)	50.6 (±11.9)	51.6 (±11.6)	49.0 (±12.3)	**.014**
Male gender, n_2 (%)	146 (70.9%)	87 (70.7%)	59 (71.1%)	.956
African American race, n_2 (%)	28 (13.6%)	5 (4.1%)	23 (27.7%)	**<.001**
Loss to follow-up, n_1(%)*	65 (20.4%)	4 (3.1%)	61 (32.6%)	**<.001**
SARS-CoV-2 RT-PCR Positive assay during baseline testing, n_1(%)*	47 (14.8%)	4 (3.1%)	43 (23.0%)	**<.001**
SARS-CoV-2 RT-PCR Positive assay during follow-up testing, n_2(%)	14 (6.8%)	4 (3.3%)	10 (12.0%)	**.014**
Follow-up duration, days (Median, IQR)	19 (15 – 26)	19 (14 – 20)	17 (16 – 30)	.144[Φ]

* Loss to follow-up and SARS-CoV-2 RT-PCR positive assay during baseline testing were calculated based on baseline population count (n_1).
Φ Compared by Kruskal–Wallis test.
⊗ n_1 indicates the number of guests at baseline; n_2 indicates the number of guests at follow-up.

and was voluntary to the shelter guests, asked questions regarding face covering and social distancing (Supplementary Data 2). Shelter guests in Brockton were not provided with pretesting surveys but were given the opportunity to complete the post-testing survey.

Statistical analysis

Descriptive analysis

We compared the baseline characteristics of age, gender, and race between the guests in Brockton and Quincy shelter sites using descriptive analyses. For questions on social distancing and face-covering practice, we also analyzed descriptively. Chi-squared tests were performed for categorical variables. For continuous variables, we conducted t-tests for mean tests and Kruskal-Wallis tests for median tests for variables not normally distributed. The one-way analysis of variance (ANOVA) was used to compare differences between the means of three or more groups. We also compared the SARS-CoV-2 RT-PCR positive assay rate at baseline and follow-up between the shelter sites.

COVID-19 symptoms analysis

In terms of COVID-19 symptoms analysis, we evaluated the frequency for each of the ten common COVID-19 symptoms collected. We calculated the Likelihood Ratio (LR) to explore the value of using symptoms as a screening test. We used standard logit intervals to calculate confidence limits for likelihood ratios. The analysis was performed using Stata 16 statistical software [20] and MedCalc's free statistical calculator [21].

Modeling

In the first model, we used logistic regression to estimate the odds ratio of having a SARS-CoV-2 RT-PCR positive assay result at follow-up among the Brockton shelter guests versus the Quincy shelter guests by adjusting for age, race, and gender. In the second model, we constructed a logistic regression model with inverse probability weighting (IPW) of exposure [22]. IPW is a standardization method that is often used to control for bias due to unequal probabilities of the selection process [23]. In this present study, the exposure weights were calculated based on the inverse of an individual's probability of being a Brockton guest, given their age, gender, and race characteristics. We further stabilized the weights by multiplying the inverse probability with the probability of receiving the treatment to reduce the weights' variability.

To account for potential biases arising from censoring due to the high-mobility nature of the homeless population, we constructed a marginal structural model (MSM) with censoring weights to estimate the relationship between the mitigation strategy and having a positive assay result at follow-up by creating pseudopopulations that would be observed without dropouts [22]. The censoring weights used in the MSM were calculated by the IPW method to account for the issue that study participants varied in their probability of censoring in the study due to certain characteristics.

Sensitivity analysis

We compared the estimates between the three models and their 95% confidence intervals. Furthermore, we estimated the E-values for sensitivity analysis [24]. We calculated the E-values for both the observed association estimate after adjusted for the measured confounders and the lower limit of the 95% confidence interval of the estimate closest to the null.

All p-values <0.05 were considered significant. All statistical analyses except the analysis of the COVID-19 symptoms were conducted using R Statistical Software (version 3.6.1; R Foundation for Statistical Computing, Vienna, Austria) [25]. R packages of "causalsens," [26] "geepack," [27] and "sandwich" [28] were used for analysis.

Results

Characteristics of the study population

A total of 318 shelter guests were tested for SARS-CoV-2 at baseline, of whom 131 were in Quincy and 187 were in Brockton. Forty-seven guests with baseline SARS-CoV-2 positive assay result were excluded (4 at Quincy and 43 at Brockton, $P < .001$), and 65 guests lost follow-up during the study period (4 at Quincy and 61 at Brockton, $P < .001$), the final population was comprised of 206 guests (123 at Quincy and 83 at Brockton). (Table 1)

The median durations (IQR) of the follow-up period in Quincy and Brockton shelters were 19 (14–20) days and 17 (16–30) days ($P = .144$), respectively. Among the included guests, 4 (3.3%) Quincy guests and 10 (12.0%) Brockton guests had positive test results at follow-up (P-value = .014). A subpopulation analysis of Quincy's three shelter sites can be found in Supplementary Table 1, of which age (P-value < .001) and follow-up duration (P-value < .001) were distributed differently across the three Quincy shelters.

Table 2 compiled the number of the guests of Quincy shelter reporting symptoms during baseline assessment, as compared to their SARS-CoV-2 assay results. 117 out of 131 guests of Quincy shelter responded to the survey (response rate 89.3%). This evaluation, conducted at baseline, showed that most of the symptoms had nonsignificant likelihood ratios. Only cough had a slightly increased positive likelihood ratio (LR: 2.58; 95% CI: 1.17–5.70).

Table 3 provides the logistic regression models' results comparing the Brockton guests to the Quincy guests. In the IPW model accounting for age, gender, and race, Brockton guests had 5.42-time odds of having a positive result than their Quincy counter-

Table 2
Clinical presentation of study participants and test performance of symptom checks at the Quincy shelters at baseline

Clinical presentation	SARS-Cov-2 status		Positive likelihood ratio	Negative likelihood ratio
	Positive (n = 5)	Negative (n = 112)		
Fever/chills	0	1	0	1.01 (0.99–1.03)
Cough	3	26	2.58 (1.17–5.70)	0.52 (0.18–1.53)
Shortness of breath	0	9	0	1.09 (1.03–1.15)
Sore throat	1	6	3.73 (0.55–25.42)	0.85 (0.54–1.31)
Body ache	1	12	1.87 (0.30–11.67)	0.90 (0.58–1.40)
Running nose	0	8	0	1.08 (1.02–1.13)
Loss of taste or smell	0	1	0	1.01 (0.99–1.03)
Fatigue/feeling run down	0	10	0	1.10 (1.04–1.16)
Nausea	1	0	–	0.80 (0.52–1.24)
Diarrhea	0	1	0	1.01 (0.99–1.03)

Table 3
Effects of being a Brockton shelter resident on having positive PCR testing for COVID19 in three statistical models: logistic regression models, a marginal structural model with IPW, and a marginal structural model with IPCW

Covariate	Odds ratio (95% confidence interval)		
	Logistic regression	IPW[$] (stabilized)	IPCW[Φ] (stabilized)
Being a Brockton shelter resident	**5.05 (1.45–17.54)**[*]	**5.42 (1.60–18.36)**[**]	**6.21 (1.86–20.77)**[***]
African American race	2.05 (0.46–9.18)	1.86 (0.43–8.00)	1.17 (0.27–5.15)
Male gender	1.49 (0.42–5.27)	1.90 (0.51–7.12)	1.75 (0.49–6.22)
Age	0.99 (0.94–1.04)	1.01 (0.95–1.07)	0.99 (0.93–1.05)

[*] IPW: inverse probability weighting.
[Φ] IPCW: inverse probability censoring weighting.
[*] $p < .05$, [**]$p < .01$, [***]$p < .001$.

parts (95% CI = 1.60, 18.36). When using IPW to further adjust for censoring (IPCW), Brockton guests were found to have 6.21-time odds of having a positive result than Quincy guests (95% CI = 1.86, 20.77). The sensitivity analysis showed that the E-value for the effect estimate in the IPCW model is 11.27 and the E-value for the lower CI limit of the effect estimate is 2.87.

Supplementary Table 2 summarized the frequencies of practicing social distancing and face-covering between Brockton and Quincy guests. Ninety-six out of 206 guests responded to the survey (response rate of 46.6%). Guests at Quincy had higher adherence to social distancing practices (*P*-value = .013) and mask-wearing in the shelter (*P*-value = .003) than the Brockton guests.

Discussion

In this study, we examined the effectiveness of mitigation strategies implemented in two separate homeless shelters in the Greater Boston area during the initial months of the COVID-19 pandemic. We found guests in the shelter that utilized temporary outdoor tents for decompression were 6.21 times more likely to test positive for SARS-CoV-2 at follow-up testing than the guests in the shelter that depopulated them to three separate buildings, adjusting for censoring, age, gender, and race. To the best of our knowledge, this is the first prospective cohort study that compares the effectiveness of different decompression strategies among homeless shelters using real-world evidence, as other studies reported mitigation strategy results based on single-institution evidence [29,30], simulation models [31], or qualitative or descriptive analysis [29,32]. We also found that daily temperature and symptom check of guests alone were less effective in identifying and reducing SARS-CoV-2 transmission in shelters. Additionally, guests at the shelter with more positive results at follow-up testing were less compliant with social distancing and face-covering guidelines.

One recent study developed a microsimulation model to assess the cost-effectiveness and clinical outcomes of mitigation strategies, and found that daily symptom screening and decompression intervention could substantially decrease SARS-CoV-2 transmission and reduce costs for homeless shelters compared to no intervention [31]. Our study result further demonstrates the importance of transmission risk mitigation through population decompression for homeless shelters. Our results also showed daily temperature, and symptom screening performed poorly among the Quincy shelters. While all Quincy shelter guests passed the twice-daily temperature and symptom checks prior to baseline testing, 5 guests reported symptoms on our pretesting survey in the clinic, and 5 guests tested positive for SARS-CoV-2. This echoes with previous studies suggesting a large proportion of shelter guests with positive SARS-CoV-2 RT-PCR results presented as asymptomatic infections [33] and COVID-19 clinical symptoms could be present in other diseases complicating the daily symptom check routine [30]. Furthermore, some shelter guests chronically use acetaminophen or ibuprofen for their medical conditions, which could mask their symptoms. Some guests have reported they responded untruthfully out of fear of losing shelter. Our finding supports that accurate universal surveillance, such as routine SARS-CoV-2 RT-PCR testing, instead of symptom-triggered testing should be implemented together with decompression strategy in homeless shelters.

This study found that shelter guests who used temporary tents had six times higher odds of contracting SARS-CoV-2. We hypothesize that temporary outdoor tents to decompress the shelter population could not provide stable accommodation for the guests during extreme weather events. In fact, during several thunderstorms over the study period, the Brockton shelter had to temporarily relocate outdoor tent guests to inside the building for their safety. During these incidents, it was reported shelter guests were not able to maintain social distancing. Moreover, without proper indoor sheltering space, these individuals relocated to outdoor tents could be at higher risks of cold-related illness. Previous studies have shown excess mortality during harsh winter [34]. This real-world evidence suggests homeless service organizations may improve their mitigation strategies by converting existing buildings such as a gym or school dorms to temporary shelters under the assistance of local governments.

Although repurposing hotels and other facilities to deconcentrate homeless shelters appear to be an effective strategy, many barriers remain in adopting the approach [35]. It was not until

February 2021 that the administration confirmed that the Federal Emergency Management Agency (FEMA) would fully cover eligible costs related to COVID-19-related noncongregate sheltering for the homeless population through its FEMA Public Assistance program [36]. Nonetheless, local governments face many deterrents to apply for the allocated funding. First, local governments have to pay upfront costs, and the timeline of reimbursement is unclear. There is no guarantee of reimbursement. Not every application for reimbursement will be approved, and not every expenditure in an approved application will be covered [37]. Second, the funding application process is time-consuming, usually taking several months for the local government to prepare and collect documents required for funding applications [37]. Third, the local governments have to search for funding opportunities and go through the process of application. This is a labor-intensive work. Larger cities can hire consultants to seek funding opportunities and staff to specifically work on the applications, while smaller towns may not afford the administrative burden [38]. Besides funding insufficiency, there is a shortage of supply of hotel rooms and facilities [35]. The situation becomes even more challenging for some communities that faced opposition from community residents and hotel owners [39]. The mitigation strategies that local communities could adopt relied heavily on the resources, emergency management experiences, and capacity of local governments; this leads to regional disparities in the services and care that homeless populations could receive.

Another important finding in this study is the high mobility among people experiencing homelessness, which poses a significant challenge for service providers and researchers. We observed 3.1% and 32.6% loss to follow rate in Quincy and Brockton shelters in the study. The high mobility rate within a shelter could increase the risk of SARS-CoV-2 transmission among its guests. On the other hand, unstable residential condition elevates the risk of SARS-CoV-2 infection among people experiencing homelessness [40]. Our finding supports the urgent need to provide stable housing and accessible medical and behavioral health services for the homeless population to reduce their mobility patterns [41].

Even with treatment advancement and national vaccine program in place, the pandemic is still a threat, especially to the vulnerable and marginalized populations. This study provides some valuable suggestions for stakeholders on actions to protect the homeless people. First, a cost-effectiveness analysis could be a helpful next step to identify actions and policies that should be prioritized. Second, governments at each level should assist homeless service providers in decompressing the shelters by providing bridge funds, streamlining funding sources, and negotiating emergency placement contracts with local hotel or motel owners. Third, the federal government should keep providing decompression funding and make the information of funding opportunities more accessible to local governments everywhere in the United States. The federal government could simplify the application process and expand the eligibility of items for reimbursement [42]. Fourth, local governments at different levels could collaborate to deal with financial concerns related to the decompression strategy. For example, the city government of Missoula, Montana, purchased a motel, allowing the county to lease it while applying for FEMA reimbursement [43]. Last but not least, in the long run, interventions targeting the upstream causes of homelessness such as providing affordable housing and accessible medical and behavioral health services are necessary to mitigate the adverse impacts of homelessness.

This study has several strengths. First, we analyzed data from two cohorts of homeless shelters that adopted different decompression strategies. Our study is the first cohort study to provide such comparisons. The prospective study design allows us to examine the temporal relationship between the mitigation strategies and SARS-CoV-2 surveillance assay results. Second, we examined the compliance of social distancing and face-covering among shelter guests through voluntary surveys, which provides further insights on risk prevention on an individual level among shelter guests. Lastly, the estimates derived from this analysis were robust. The sensitivity analysis using E-values showed that our effect estimates were not likely to be explained away by unmeasured confoundings.

Nevertheless, our study bears several limitations. First, we had a high loss to follow-up rate at the Brockton shelter, which could potentially bias the effect estimates. To reduce the impact of censoring, we used IPW to adjust for loss to follow up. We obtained a significantly elevated odds ratio that is higher than the model's estimate without adjusting for loss to follow up. Despite the censoring issue that could bias the estimate, it did not seem to alter the data's conclusion. Second, different sample collection methods were used at the baseline SARS-CoV-2 testing due to a testing supply shortage in March 2020. However, several recent studies have examined the analytical efficiency and sensitivity of different testing methods and found them comparable [44]. Moreover, all collection methods were nasopharyngeal in both Quincy and Brockton shelters during the follow-up testing; the measures of the outcome of interest were consistent across shelters. Lastly, the study population was derived from homeless shelters in two urban regions in Massachusetts; therefore, the generalizability of our study may be limited to similar urban shelters. Moreover, we were not able to include county/city-level covariates, such as community COVID-19 positivity rate and median household income, into the model. Since there are only two counties in the data, the exposure variable (Brockton vs. Quincy) will fully predict the county-level covariates' values and cause overfitting and multicollinearity [45,46].

Conclusion

The present study found that guests in the shelter that utilized temporary outdoor tents for decompression were 6.21 times more likely to be tested positive for SARS-CoV-2 than guests in the shelter that decompressed their guests to other indoor facilities. Daily temperature and symptom checks performed poorly alone and should be combined with routine SARS-CoV-2 RT-PCR surveillance. The study highlights the importance of having a stable and adequate indoor decompression strategy for homeless shelters, which is a pressing issue for homeless service providers due to the mass unemployment, housing, and eviction crisis caused by COVID-19[4]. We call on local governments to assist homeless shelters in decompressing their population with suitable indoor facilities and improving testing capacities to protect this vulnerable population during the pandemic.

Acknowledgments

Author contribution

All authors contributed evenly in the study concept and design, acquisition, analysis, interpretation of data, drafting, and critical revision of the manuscript. Drs. Yang, Hsu, Lan, and Wei contributed to the statistical analysis. Drs Yang and Hsu had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Funding sources

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.annepidem.2021.08.023.

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