

The impact of the COVID-19 pandemic among migrants in shelters in Tijuana, Baja California, Mexico

Iletza Bojorquez-Chapela,¹ Steffanie A Strathdee,² Richard S Garfein,² Constance A Benson,² Antoine Chaillon,² Caroline Ignacio,³ Jaime Sepulveda⁴

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¹Department of Population Studies, El Colegio de la Frontera Norte, Tijuana, Baja California, Mexico

²Division of Infectious Diseases and Global Public Health, School of Medicine, University of California San Diego, La Jolla, California, USA

³Department of Medicine, University of California San Diego, La Jolla, California, USA

⁴Institute for Global Health Sciences, University of California San Francisco, San Francisco, California, USA

Correspondence to

Dr Jaime Sepulveda;
Jaime.Sepulveda@ucsf.edu

ABSTRACT

Introduction Migrants, especially those in temporary accommodations like camps and shelters, might be a vulnerable population during the COVID-19 pandemic, but little is known about the impact of the pandemic in these settings in low-income and middle-income countries. We assessed SARS-CoV-2 seropositivity and RNA prevalence, the correlates of seropositivity (emphasising socially determined conditions), and the socioeconomic impacts of the pandemic among migrants living in shelters in Tijuana, a city on the Mexico-US border.

Methods We conducted a cross-sectional, non-probability survey of migrants living in shelters in Tijuana in November–December 2020 and February–April 2021. Participants completed a questionnaire and provided anterior nasal swab and blood samples for detection of SARS-CoV-2 RNA and antibodies (IgG and IgM), respectively. We explored whether SARS-CoV-2 infection was associated with sociodemographic and migration-related variables, access to sanitation, protective behaviours and health-related factors.

Results Overall, 481 participants were enrolled, 67.7% from Northern Central America, 55.3% women, mean age 33.2 years. Seven (1.5%) participants had nasal swabs positive for SARS-CoV-2 RNA and 53.0% were SARS-CoV-2 seropositive. Avoiding public transportation (OR 0.59, 95% CI 0.39 to 0.90) and months living in Tijuana (OR 1.06, 95% CI 1.02 to 1.10) were associated with seropositivity. Sleeping on the streets or other risky places and having diabetes were marginally associated with seropositivity. Most participants (90.2%) had experienced some socioeconomic impact of the pandemic (eg, diminished income, job loss).

Conclusion Compared with results from other studies conducted in the general population in Mexico at a similar time, migrants living in shelters were at increased risk of acquiring SARS-CoV-2, and they suffered considerable adverse socioeconomic impacts as a consequence of the pandemic. Expanded public health and other social support systems are needed to protect migrants from COVID-19 and reduce health inequities.

INTRODUCTION

The International Organization for Migration uses ‘migrant’ as an umbrella term,

Key questions

What is already known?

- ▶ Migrants face situations that could disproportionately place them at risk during the COVID-19 pandemic, both of infection and of the social consequences of the pandemic.

What are the new findings?

- ▶ This is one of the first surveys of migrants in shelters in a middle-income country.
- ▶ Seroprevalence of antibodies to SARS-CoV-2 was almost twice as high as that of the general population.
- ▶ More than 90% of migrants had experienced adverse social consequences of the pandemic.

What do the new findings imply?

- ▶ The study provides evidence of the need of public health and social support measures for migrants in the context of the pandemic.

encompassing people who change their place of residence for different reasons, including documented and undocumented migrants, those who move for economic reasons, and people who flee their countries of origin because of violence or natural disasters, who are entitled to recognition as refugees.¹ The term includes immigrants who have been living in receiving countries for years, as well as recent arrivals and persons who are still in transit between their countries of origin and their intended destination. However, different types of migrants may experience different vulnerabilities. Migrants, refugees or asylum seekers living in what are intended to be temporary accommodations, such as camps and settlements, could be more at risk of SARS-CoV-2 infection because of overcrowding, unhygienic conditions and poor access to COVID-19 mitigation strategies (ie, masks). At the same time, the limited social inclusion of these individuals could make them more vulnerable to socioeconomic hardship due to the pandemic.

The COVID-19 pandemic has disproportionately impacted socially vulnerable populations.^{2 3} The pandemic, as well as the measures implemented to control it, and their socioeconomic consequences, can impact migrants both directly (increased risk of transmission) and indirectly (other health and social consequences).^{4 5} Of particular concern are intransit migrants, refugees and asylum seekers, and those residing in camps and other overcrowded settings with limited access to resources for hygiene or physical distancing. A position paper in the European Union recommended that these settings be given priority for SARS-CoV-2 testing.⁶ Migrants in such settings typically have limited access to healthcare, employment and social services, and are therefore at risk of the social and economic impacts of lockdown and other measures.⁷⁻⁹

Estimates of the incidence of SARS-CoV-2 infection among migrants are scarce, as most health information systems do not disaggregate by migration status.¹⁰ Still, a recent systematic review concluded that the risk of SARS-CoV-2 infection was higher among migrants, as compared with native-born populations.⁷ Factors possibly contributing to the increased risk among migrants include living in detention centres, camp settings and other overcrowded spaces, as well as working in occupations that require close contact with people. However, the review was limited to high-income countries. Less is known about the situation in low-income and middle-income countries, despite the fact that they host over one-third of the international migrant population, and four of the five top host countries for refugees were in this category in 2018.¹¹

Our study addressed migrants living in shelters run by civil society organisations (CSOs) in Tijuana, Baja California, Mexico. Tijuana, a city of 1.9 million inhabitants at the Mexico-US border, has historically been a hub for Mexican migrants travelling towards or returning from the USA.¹² In the past decade, more migrants from Central America and other countries have arrived in the city, with the final aim of reaching the USA.^{13 14} Thousands of these intransit migrants and asylum seekers became stranded in Tijuana due to migration policies, such as the 'Remain in Mexico' one, which forces them to wait on the Mexican side of the border until their asylum claims are processed by US' authorities.^{14 15} These migrant flows are the result of violence, poverty and natural disasters in Central America and other regions,¹⁶ and have been considered a humanitarian emergency.

Once in Tijuana, although some migrants have the resources to pay for shared rooms or apartments and informal camps have been established for limited periods, the main source of accommodation (and other forms of support) for migrants have been migrant shelters operated by CSOs. A study conducted in March 2020 identified 32 of these shelters in the city,¹⁴ with capacity for 5101 persons.

Before the pandemic, it took about a month on average for migrants to transit through Mexico.¹⁷ At the time of

this study, those en route from Mexico's southern border to the US could have been exposed to SARS-CoV-2 infection either in their countries of origin (eg, reported daily cases had remained high in Honduras from July to October 2020),¹⁸ or in transit through Mexico, where at the end of 2020 a second wave of infection was occurring. Migrants could also have been exposed during periods in migrant detention facilities in Mexico or the USA.

In this study, we evaluated the impact of the COVID-19 pandemic on migrants living in shelters in Tijuana. We aimed to (1) determine the RNA and antibody prevalence of SARS-CoV-2 among migrants in shelters in Tijuana; (2) identify correlates of SARS-CoV-2 seropositivity with an emphasis on socially determined conditions and (3) describe the socioeconomic impact of the pandemic in this population.

METHODS

Design and participants

We conducted a cross-sectional, non-probability survey of migrants living in shelters in Tijuana. We aimed to conduct interviews in all identified shelters, and to enrol all migrants who fulfilled the inclusion criteria (see below). Field work started in November 2020, but it was interrupted in December because of health regulations due to the increase in COVID-19 cases in Tijuana. Data collection resumed in February, through April 2021.

Participant recruitment was conducted by trained interviewers, who visited the shelters and invited all adult residents to respond to a short screening questionnaire. If eligible, informed consent was obtained before applying the questionnaire using laptop computers.

We defined the inclusion criteria with the aim of enrolling the most vulnerable population of in-transit migrants and asylum seekers. Thus, we recruited persons either: (1) born in a Latin American or Caribbean country other than Mexico, who had been in Tijuana for ≤ 5 years or (2) born in a Mexican state other than Baja California (the state where Tijuana is located), who had arrived in Tijuana ≤ 1 year prior due to deportation from the US or internal displacement in Mexico. In addition, participants had to be ≤ 18 years old, able to respond the survey questionnaire in Spanish, English or French and to provide written informed consent.

The survey questionnaire assessed sociodemographic information, migration history, socioeconomic impact of the pandemic, hygiene and living conditions, health status, past COVID-19 infection and testing, COVID-19-related attitudes and behaviours, mental health and other topics.

SARS-Cov-2 testing

To assess SARS-CoV-2 infection, we collected anterior nasal swab and blood samples. Anterior nasal swabs were collected to test for viral RNA—an indicator of active infection. Blood samples were tested for SARS-CoV-2 antibodies—an indicator of past infection. Anterior

nasal swabs were self-collected by participants following standard procedures¹⁹ under the supervision of nurses or nursing students with experience in sample collection, and nurses collected blood samples by venipuncture. For the purposes of standardisation, the staff received training on the project's methods for sample collection, handling and preparation. Staff and participants wore personal protective equipment during data collection.

After collection, nasal swabs were placed in coolers containing ice packs and moved to a refrigerator at the study office each day. Once a week, the samples were transported to the University of California in San Diego Center for AIDS Research lab for testing. During the first period of recruitment, viral transport media (VTM) was in very high demand and priority for it was given to hospitals, so phosphate-buffered saline (PBS) was used instead. The use of PBS was validated using known controls, showing that there was no loss of sensitivity vs VTM and the results were comparable. VTM was used for the second recruitment period. A pooling approach based on the Fluxergy system (Irvine, California, USA) was employed to detect SARS-CoV-2 RNA. Briefly, equal volumes (14 µL) of VTM from each participant were combined into one pool. The remaining VTM was stored individually for subsequent testing should the pool require deconvoluting. If a mini pool test was positive, all samples from that pool were tested individually.²⁰

Blood samples were collected by venipuncture. Samples were transported in coolers containing ice packs to the study office for centrifugation, and kept refrigerated until they were transported weekly to Genalyte, a Clinical Laboratory Improvement Amendments-certified laboratory in San Diego, California. The lab ran a SARS-CoV-2 Serology panel²¹ to detect IgG and IgM antibodies to five SARS-CoV-2 antigens (Nucleocapsid, Spike S1-S2, Spike S1, Spike S1-RBD, Spike S2) within a multiplex format based on photonic ring resonance. From the panel, a machine learning algorithm using the Random Forest Ensemble method with 3000 decision trees was employed by the lab to interpret results as positive, negative or indeterminate for SARS-CoV-2 antibodies.²²

Variables

Our three outcomes of interest in this analysis were SARS-CoV-2 RNA positivity in nasal swab samples, SARS-CoV-2 antibody seropositivity and socioeconomic impact of the pandemic. The percentage seropositive was calculated excluding indeterminates and participants who had already received a vaccine. To evaluate the socioeconomic impact, we assessed participants' responses to four dichotomous questions about possible adverse effects of the pandemic (ie, loss of income, loss of job, inability to pay rent, and forced to leave the migrant shelter). Socioeconomic impact was defined as experiencing at least one of them (yes/no).

The low number of nasal swabs that tested RNA positive precluded an analysis of correlates of active infection. As potential correlates of SARS-CoV-2 seropositivity,

we considered possible risk factors with an emphasis on socially determined characteristics. These included sociodemographic and migration variables (age, gender, educational level, working, having slept on the streets or other risky places, region/country of origin and having spent time in migrant detention), access to sanitation (ordinal variables reflecting frequency of access to water and soap), protective behaviours (dichotomous variables indicating having washed hands, self-isolating at home or shelter and wearing a mask in public frequently or very frequently since the beginning of the pandemic; and dichotomous variables indicating having never or rarely used public transport or visited crowded public places in the same period) and health-related variables (previous diagnosis of diabetes, hypertension, chronic obstructive pulmonary disease, cardiovascular disease or obesity). Since the dynamics of the pandemic at different times might have influenced seropositivity, we also included time in Tijuana and month of study enrolment.

As potential correlates of socioeconomic impact, we included the same sociodemographic and migration variables as above, and time lived in Tijuana, as these measures could reflect the degree of social inclusion/exclusion of migrants in the city.

Analysis

Bivariate and multivariable logistic regression models were adjusted to identify factors associated with SARS-CoV-2 seropositivity and social impact of the pandemic. For the multivariable models, likelihood ratio tests were used to compare nested models, and Akaike and Bayesian Information Criteria were used to assess goodness-of-fit. Independent variables were kept in the model if they improved the fit or were statistically significant with $p < 0.10$. We handled missed data with pairwise deletion.

Patient and public involvement

Before starting recruitment, the researchers presented the project to persons responsible for migrant shelters in Tijuana and discussed the methods and research questions with them. Some methods for approaching migrants were modified based on their suggestions to minimise the burden of the time and other potential sources of discomfort for participants. The results of the survey were presented to all participating shelters, and participants received their lab results together with brief counselling on the pertinent health issues.

RESULTS

As shelters open and close depending on the CSOs' resources and other factors, by the time fieldwork for this study was conducted only 27 shelters were identified as operational (in contrast with the previously reported 32), of which we were able to contact 25. Of the 25 shelters contacted, seven refused to participate in the study. According to the persons responsible for the 18 participating shelters, there were a total of 856 migrants (including minors) residing there during the

Table 1 General characteristics of participants, total and by fieldwork period

Variable	Total (n=481)	November-December 2020 (n=84)	February-April 2021 (n=397)	P value*
Sociodemographic and migration variables				
Age—years, mean (SD)	33.2 (10.7)	33.1 (10.5)	33.3 (10.7)	0.883
Female (%)	55.3	53.6	55.7	0.726
Educational level (%)				0.944
None	6.0	7.1	5.8	
Primary or less	38.9	36.9	39.3	
Secondary or technical equivalent	27.0	27.4	27.0	
Preparatory or technical equivalent	19.1	17.9	19.4	
Some college or more	8.9	10.7	8.6	
Travelling with minors	68.4	58.3	70.5	0.029
Working in the past week (%)	34.3	56.0	29.7	<0.000
Slept in a risky place in the past 3 months ² (%)†	17.3	20.2	16.6	0.426
Country of origin (%)				0.051
Mexico	25.2	20.2	26.2	
Honduras	47.0	39.3	48.6	
Guatemala	10.4	11.9	10.1	
El Salvador	10.2	15.5	9.1	
Other	7.2	13.1	6.0	
Was in migrant detention before coming to Tijuana (%)	50.3	35.7	53.4	0.003
Months in Tijuana, mean (SD)	3.4 (1.0)	7.7 (0.7)	4.3 (0.4)	<0.001
Access to sanitation and protective/risk behaviours				
Always has access to water for handwashing (%)	92.5	96.4	91.7	0.374
Always has access to soap (%)	87.7	96.4	85.9	0.084
Washed hands or used hand sanitiser frequently or very frequently (%)	89.8	94.1	88.9	0.158
Self-isolated at home or in a shelter frequently or very frequently (%)	47.9	65.5	44.2	<0.001
Wore a mask when in public frequently or very frequently (%)	93.4	92.9	93.5	0.843
Used public transport never or rarely (%)	40.8	29.8	43.1	0.024
Visited crowded places never or rarely (%)	80.3	82.1	79.9	0.631
Health and COVID-related variables				
Diabetes (%)	4.4	1.2	5.0	0.117
Hypertension (%)	7.7	6.0	8.1	0.510
COPD (%)	7.3	7.1	7.3	0.959
Cardiovascular disease (%)	2.1	2.4	2.0	0.831
Obesity (%)	4.8	10.7	3.5	0.005
Thinks she/he has had COVID-19 (%)	12.9	18.1	11.8	0.124
Previously tested positive for SARS-CoV-2 (%)‡	11.4	11.1	11.4	0.977
Positive for SARS-CoV-2 antibodies§ (%)	53.0	46.3	54.5	0.181
Positive SARS-CoV-2 RNA (nasal swab) (%)	1.5	0	1.8	0.217

*X² test, or t test, comparing between recruitment periods.

†Slept in a vehicle, correctional institution, drug treatment centre, streets/beach/canal.

‡Percentage calculated over those tested previously (9 in first period, 105 in second period).

§Percentage excludes six participants who had already received a COVID vaccine. Indeterminate results are also excluded.

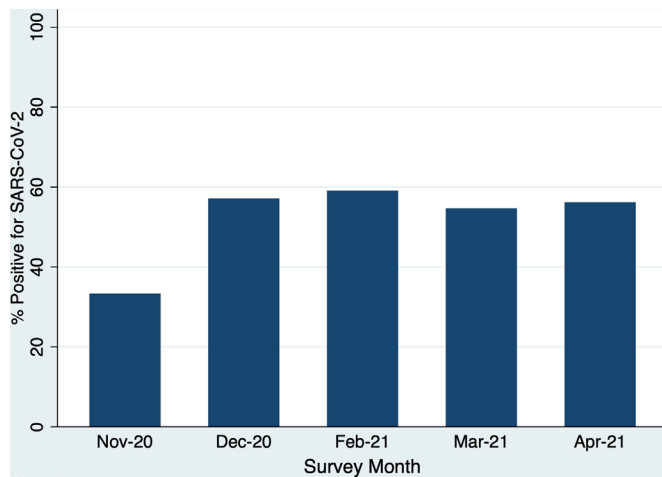


Figure 1 SARS-CoV-2 antibody seroprevalence among migrant shelter residents, by month of recruitment.

study period. We screened 586 adults, of whom 490 were eligible, and 481 agreed to participate.

Most participants (67.6%) were from one of the three Northern Central America countries (Honduras, Guatemala or El Salvador) (table 1), and 77.6% of all participants had applied or intended to apply for asylum in the USA. Between the two recruitment periods there were major changes in the composition of migrants residing in the shelters. Whereas in November–December most participants had lived in Tijuana for several months (7.7 months on average), by February–April a new flow of migrants had arrived, many of them directly from their countries of origin, or had been returned from the USA rapidly after attempting crossing to apply for asylum. In the second period fewer participants reported working in Tijuana, and fewer were able to shelter in place, but there was a higher proportion who had spent time in migration detention, or had never or rarely used public transportation during the pandemic.

Overall, over half (53.0%) of participants tested SARS-CoV-2 seropositive (table 1). Seroprevalence increased from 46.3% in the first period, to 54.5% in the second period, and especially from November to December 2020 (figure 1). The prevalence of RNA positive samples was low, with only seven (1.5%) participants having a positive result, all of them in the second period of data collection. Of the 237 participants who tested seropositive, 52 had previously been tested for SARS-CoV-2, of whom 13.5% had tested positive on that occasion (not shown in table 1).

In the bivariate analysis (table 2), using public transportation, having a diagnosis of diabetes, a longer duration living in Tijuana, and month of survey completion, were significantly associated with SARS-CoV-2 antibody seropositivity. In the multivariable model (table 2), using public transportation, living in Tijuana and month of survey remained statistically significant. Sleeping in a risky place and having a previous diagnosis of diabetes were marginally significant at the $p < 0.10$ level.

As for the social impacts of the pandemic (table 3), most participants experienced diminished income and loss of work. Nearly one-third (31%) had to move out of their place of residence because they were not able to pay for it. Overall, 90.2% of participants reported having experienced at least one of the social impacts of the pandemic assessed in this study, and the impact was higher in the second survey period. In the multivariable model (table 4), being male and having lived in Tijuana for a shorter duration were associated with higher odds of experiencing the socioeconomic impacts of the pandemic, while travelling with minors marginally increased the odds of experiencing socioeconomic impacts.

DISCUSSION

In this study of migrants in Tijuana, we found that over half (53.0%) tested SARS-CoV-2 antibody seropositive, which is more than double the prevalence estimate (25%) reported by Mexico's National Health and Nutrition Survey-COVID-19 (ENSANUT COVID-19), conducted in the second half of 2020.²³ A survey of the general population in Baja California in February 2021 also found a much lower (21%) seroprevalence.²⁴ A nationwide study based on health facilities in Mexico found a seroprevalence of 33.5% in December 2020, at the peak of the second wave of the epidemic in the country. According to that study, the seroprevalence for the northwest region (including Baja California) was 40.7%.²⁵ A study conducted among people who inject drugs in Tijuana during the same period as this study found that 36.5% tested SARS-CoV-2 positive.³ Our seroprevalence results are, therefore, consistent with the review by Hayward *et al* who concluded that migrants have been disproportionately affected during the pandemic, when compared with the native-born or general population and should be targeted in prevention efforts.⁷ A report by the Organisation for Economic Co-operation and Development also concluded that immigrants are over-represented among COVID-19 cases in most countries, with the risk estimated to be twice that of native-born residents.⁵ Similarly, Kondilis *et al*⁶ reported that migrants in reception facilities in Greece had 2.5–3 times higher risk of COVID-19 infection.

The small number of RNA positive nasal swabs in our sample could have resulted from actions taken by migrant shelters to prevent transmission, which might have resulted in only a few active cases at the time of the study. Anecdotally, a cluster of RNA-positive nasal swab samples was found in a single shelter, which had during that week received a group of migrants returned to Mexico by the US' migration authorities, highlighting the importance of providing the shelters with the means to establish detection and quarantine systems. Another reason might be that, while nasal swabs have good sensitivity, it is not perfect,²⁶ and pooling methods can also miss some cases.²⁰ However, it's interesting to mention

Table 2 Logistic regression analysis of factors associated with SARS-CoV-2 antibody seropositivity*

Variable	Unadjusted		Adjusted†	
	OR	95% CI	OR	95% CI
Age (years)	1.02	1.00 to 1.03	1.01	0.99 to 1.03
Female gender	1.08	0.74 to 1.57	1.39	0.91 to 2.12
Educational level				
None	Ref.			
Primary or less	1.59	0.71 to 3.60		
Secondary or technical equivalent	1.29	0.56 to 3.00		
Preparatory or technical equivalent	1.25	0.52 to 2.99		
Some college or more	2.17	0.81 to 5.83		
Travelling with minors	0.84	0.57 to 1.26		
Working in the past week	1.15	0.78 to 1.70		
Slept in a risky place in the past 3 months‡	1.26	0.77 to 2.06	1.59	0.93 to 2.71
Country of origin other than Mexico	1.21	0.79 to 1.85		
Was in migrant detention before coming to Tijuana	1.27	0.88 to 1.84		
Always has access to water for handwashing	0.91	0.46 to 1.82		
Always has access to soap	1.23	0.70 to 2.17		
Washed hands or used hand sanitiser frequently or very frequently	1.17	0.64 to 2.13		
Self-isolated in shelter frequently or very frequently	0.88	0.61 to 1.28		
Wore a mask when in public frequently or very frequently	0.67	0.32 to 1.41		
Never or rarely used public transport	0.67	0.46 to 0.97	0.59	0.39 to 0.90
Never or rarely visited crowded places	0.90	0.56 to 1.43	2.60	0.89 to 7.55
Previous diagnosis of diabetes	2.90	1.04 to 8.06		
Previous diagnosis of hypertension	1.90	0.90 to 4.00		
Previous diagnosis of COPD	1.90	0.90 to 4.00		
Previous diagnosis of cardiovascular disease	0.57	0.16 to 2.05		
Previous diagnosis of obesity	1.93	0.72 to 5.17		
Months in Tijuana	1.04	1.01 to 1.07	1.06	1.02 to 1.10
Month of recruitment				
November 2020	Ref		Ref.	
December 2020	2.56	1.04 to 6.35	2.73	1.03 to 7.18
February 2021	3.06	1.30 to 7.20	3.54	1.45 to 8.65
March 2021	2.16	1.14 to 5.34	3.92	1.68 to 9.15
April 2021	2.47	1.04 to 6.35	6.55	2.63 to 16.29

*Excludes indeterminate results. Adjusted by variables with results in the column.

†N=449, log likelihood=-292, p=0.0001.

‡Slept in a vehicle, correctional institution, drug treatment centre, streets/beach/canal.

Table 3 Social impact of the COVID-19 pandemic on participants

Variable	November–December 2020 (n=84)	February–April 2021 (n=397)	P value*	Total (n=481) %
Diminished income (%)	73.8	84.9	0.014	83.0
Lost job or reduced nuo of work hours (%)	64.3	71.8	0.171	70.5
Lost home because he/she could not pay rent (%)	20.2	33.3	0.019	31.0
Had to leave a migrant shelter (%)	13.1	5.8	0.018	7.1
Any social impact (%)†	83.3	91.7	0.019	90.2

*X² test comparing between time periods.

†Diminished income, lost job or had to leave the place he/she was living in.

Table 4 Multivariable logistic regression analysis of factors associated with social effects of the COVID-19 pandemic*

Variable	OR	95% CI
Female	0.42	0.19 to 0.89
Travelling with minors	2.09	0.97 to 4.50
Time in Tijuana (months)	0.96	0.93 to 0.99

*Adjusted by the variables that appear in the table. N=477, ll=-142, p=<.0022.

that the aforementioned study of people who inject drugs did not find any RNA positive individuals.³

As for potential socially determined risk factors, we found that using public transportation, duration of living in Tijuana, and the survey month, were associated with SARS-CoV-2 seroprevalence. The association with survey month is likely a reflection of the dynamics of the epidemic in Mexico and the migrants' countries of origin. In addition to coming in close contact with others, public transportation is likely a proxy for working away from home/shelter during the pandemic period, as well as using public transportation as a means of migrating to the Mexico-US border. The finding that living longer in Tijuana was associated with higher SARS-CoV-2 seroprevalence could reflect more opportunities for social interaction, which might include physical proximity with more people, as opposed to newcomers who stay at the shelters without going out. As the social interactions of migrants outside of shelters would likely occur in environments such as public transportation, informal employment or crowded accommodations, this increased risk can be interpreted as the result of unequal everyday conditions. In interpreting these associations, it is important to consider that they reflect factors that made some migrants more vulnerable than others, and the factors making migrants more vulnerable than non-migrants might be different.

On the other hand, the social consequences of the pandemic were apparent in that nine out of 10 participants had experienced at least one of the socioeconomic impacts we explored. In comparison, a nationally representative survey in Mexico found that the unemployment rate increased during the pandemic, and remained at approximately 10% during the second half of 2020.²⁷ According to the same survey, in August of that year the percentage of households forced to borrow money from family or friends in order to cover their expenses reached 37.7%, and 70% of households reported some degree of food insecurity. While these statistics show that the pandemic impacted the well-being of the local population too, our findings still suggest that migrants were disproportionately affected. Participants in our study who had lived in Tijuana longer appeared to be protected from these impacts, potentially because they had already begun to secure employment, or they were aware of and benefited from available economic support. Alternatively, the association might be due to reverse

causality, with those who had been more affected leaving the city and therefore not being included in our sample.

Data on COVID-19 prevalence or incidence among migrants are seldom included in national health statistics.⁵ In Mexico, while the variable 'migrant' is included in the Ministry of Health public COVID-19 surveillance database, the variable is missing in most of the cases, and given the nature of the system (a sentinel model that was not designed to estimate the population-level incidence),²⁸ as well as the lack of a denominator,²⁹ it is impossible to use those data to compare the incidence of COVID-19 in migrants versus non-migrants. On the other hand, given the small proportion of the Mexican population represented by foreign-born persons (0.96% according to the 2020 census),³⁰ the ENSANUT COVID-19 and other nationally representative surveys usually include too few migrants to make valid comparisons. Thus, surveys such as ours that focus on particular groups of migrants are a valuable tool to assess the health conditions of this underserved population.

The main limitation of our work was the non-probability sample design, which prevented us from obtaining representative estimates of the distribution of variables in the population of migrants living in shelters in Tijuana. We were unable to assess motivation for denying participation from either shelters or potential participants; however, for the latter we feel that, because of time constraints, those who worked outside the shelters (mostly men) were probably under-represented in our sample. Although we did our best to overcome this limitation by recruiting after-hours and on weekends, our sample may nevertheless over-represent those staying in the shelter full time, who might be at lower risk of infection. Detailed information on sociodemographics of shelter residents at the time of recruitment was unavailable, making it impossible to assess these and other possible sample biases; nevertheless, the fact that we included the majority of shelters in Tijuana lends confidence that we captured an adequate representation of this population. Another limitation is the cross-sectional design, which precluded us from estimating the risk for SARS-CoV-2 infection or inferring causality with the correlates we identified. The interruption of field work was another limitation, carrying the risk that some persons could have been interviewed twice. To address this, we attempted to identify repeat participants by reviewing gender, date of birth and other survey responses. A single participant appeared to have been interviewed twice, and we deleted the second interview for this analysis. Finally, since COVID-19 vaccines were just becoming available at the end of our study period, our data should not be used to draw inferences about access to COVID-19 vaccination among migrants.

CONCLUSION

This study provides evidence that migrants were disproportionately affected by the COVID-19 pandemic in Mexico, both in terms of their prevalence of past

infection and of the social impact. This points to the need for strengthening the response of the public health and other social support systems to the needs of this population. Interventions should focus on ensuring access to healthcare and COVID-19 vaccination, implementing measures for economic support when lockdown measures are in place, facilitating access to decent work, as well as supporting migrant shelters' efforts to provide migrants with a safe place to stay while in transit through Mexico, as a means to guarantee their right to health and other human rights.

Twitter letza Bojorquez-Chapela @letzaBojorquez

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REFERENCES

- International Organization for Migration (IOM). Glossary on migration. *International Migration Law* 2019;34.
- Upshaw TL, Brown C, Smith R, et al. Social determinants of COVID-19 incidence and outcomes: a rapid review. *PLoS One* 2021;16:e0248336.
- Strathdee SA, Abramovitz D, Harvey-Vera A, et al. Prevalence and correlates of SARS-CoV-2 seropositivity among people who inject drugs in the San Diego-Tijuana border region. *PLoS One* 2021;16:e0260286.
- Guadagno L. *Migrants and the COVID-19 pandemic: an initial analysis*. Geneva: International Organization for Migration, 2020.
- OECD. *What is the impact of the COVID-19 pandemic on immigrants and their children?* 2020.
- European Centre for Disease Prevention and Control. *Guidance on infection prevention and control of coronavirus disease (COVID-19) in migrant and refugee reception and detention centres in the EU/EEA and the United Kingdom*. Stockholm: ECDC, 2020.
- Hayward SE, Deal A, Cheng C, et al. Clinical outcomes and risk factors for COVID-19 among migrant populations in high-income countries: a systematic review. *J Migr Health* 2021;3:100041.
- Lebano A, Hamed S, Bradby H, et al. Migrants' and refugees' health status and healthcare in Europe: a scoping literature review. *BMC Public Health* 2020;20:1039.
- Kondilis E, Papamichail D, McCann S. The impact of the COVID-19 pandemic on migrants, refugees and asylum seekers in Greece: a retrospective analysis of national surveillance data (Feb-Nov 2020): SSRN, 2021.
- Abubakar I, Aldridge RW, Devakumar D, et al. The UCL-lancet commission on migration and health: the health of a world on the move. *Lancet* 2018;392:2606-54.
- International Organization for Migration (IOM). *World migration report 2020*. Geneva: International Organization for Migration, 2019.
- Valenzuela JM. *Por LAS fronteras del norte. Una aproximación cultural a la frontera México-Estados Unidos*. Mexico: CONACULTA-FCE, 2003.
- Gonzalez-Barrera A, Krogstad JM. What we know about illegal immigration from Mexico: Pew research center, 2019. Available: <https://www.pewresearch.org/fact-tank/2019/06/28/what-we-know-about-illegal-immigration-from-mexico/> [Accessed 9 Jul 2021].
- Coubès ML, Velasco L, Contreras OF. Migrantes En Albergues En Las Ciudades Fronterizas Del Norte De México. In: Contreras OF, ed. *Ciencias Sociales En Acción: Respuestas Frente Al Covid 19 Desde El Norte De México*. Mexico: El Colegio de la Frontera Norte, 2020: 340-57.
- Garrett TM. COVID-19, wall building, and the effects on migrant protection protocols by the Trump administration: the spectacle of the worsening human rights disaster on the Mexico-U.S. border. *Administrative Theory & Praxis* 2020;42:240-8.
- Torre Cantalapiedra E. Destino Y asentamiento en México de Los migrantes Y refugiados centroamericanos. *Trace* 2020;77:122-45.
- Jasso Vargas R, Barboza Lara C. Migración centroamericana en tránsito: estimaciones del periodo de estancia en La frontera norte de México. *Carta Económica Regional* 2017;119:15-46.
- Secretaría de Salud de Honduras/Unidad de Vigilancia de la Salud. *Boletín COVID-19. 31 de diciembre de 2020*, 2020.
- Centers for Disease Control and Prevention (CDC). *How to collect an anterior nasal swab specimen for COVID-19 testing*, 2020.
- Rawlings SA, Scott B, Layman L. Can't work from home: pooled nucleic acid testing of laboratory workers during the COVID-19 pandemic. *Open Forum Infect Dis* 2021;8:ofab129.
- United States Food and Drug Administration (FDA). Maverick SARS-CoV-2 multi-antigen serology panel V2 01030ART-01, 2020. Available: <https://www.fda.gov/media/142915/download> [Accessed 9 Jul 2021].
- Ikegami S, Benirschke RC, Fakhrai-Rad H, et al. Target specific serologic analysis of COVID-19 convalescent plasma. *PLoS One* 2021;16:e0249938.
- Instituto Nacional de Salud Pública (INSP). *Resultados Preliminares de la Encuesta Nacional de Salud Y Nutrición COVID-19*. Mexico: INSP, 2020.
- Secretaría de Relaciones Exteriores M. *Presentation of the results of the survey on prevalence of covid-19 in Baja California*. SRE, 2021.
- Muñoz-Medina JE, Grajales-Muñoz C, Salas-Lais AG, et al. SARS-CoV-2 IgG antibodies seroprevalence and sera neutralizing activity in Mexico: a national cross-sectional study during 2020. *Microorganisms* 2021;9:850.
- Jamal AJ, Mozafarhashjin M, Coomes E, et al. Sensitivity of nasopharyngeal swabs and saliva for the detection of severe acute respiratory syndrome coronavirus 2. *Clin Infect Dis* 2021;72:1064-6.
- Teruel Belismelis G, Pérez Hernández VH. Studying well-being during the Covid-19 pandemic: the Encovid-19 survey. *Revista Mexicana de Sociología* 2021;83:125-67.
- Secretaría de Salud, Subsecretaría de Prevención y Promoción de la Salud, Dirección General de Epidemiología. *Lineamiento estandarizado para La vigilancia epidemiológica Y POR laboratorio de la enfermedad respiratoria viral. Abril de 2020*. Mexico: Secretaría de Salud, 2020.
- Bojorquez I, Infante C, Vieitez I. Migrants in transit and asylum seekers in Mexico: an epidemiological analysis of the COVID-19 pandemic. *medRxiv*2020:1-20.
- Instituto Nacional de Estadística y Geografía (INEGI). Censo 2020. Presentación de resultados Mexico, 2021. Available: https://inegi.org.mx/contenidos/programas/ccpv/2020/doc/Censo2020_Principales_resultados_EUM.pdf [Accessed 9 Jul 2021].