Seroprevalence of SARS-CoV-2 antibodies among homeless people living rough, in shelters and squats: a large population-based study in France

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Abstract

Background: Overcrowded housing, as well as inadequate sanitary conditions, contribute to making homeless people particularly vulnerable to the SARS-CoV-2 infection. We aimed to assess the seroprevalence of the SARS-CoV-2 infection among people experiencing homelessness on a large city-wide scale in France, taking into account different community settings.

Methods: A consortium of outreach teams in 48 different locations including streets, slums, squats, emergency or transitional shelters and drop-in centres participated in the inclusion process. All participants consented to receive a validated rapid assay for immunoglobulins M (IgM) and G (IgG) antibodies and to answer a questionnaire on medical health conditions, comorbidities, historic of symptoms compatible with COVID-19, with a retrospective calendar of types of accommodation since COVID-19 crisis.

Results: From June 01 to August 05, 2020, 1,156 homeless participants were enrolled in the study and tested. Seroprevalence of SARS-CoV-2 IgG/IgM antibodies was 5.6% (95%CI 2.3–7.0), with a range of 2.2% in people living on the streets to 8.1% in people living in emergency shelters (P=0.009). Around one third of the seropositive participants reported symptoms with COVID-19. Compared to the general population in Marseille (3.6%), the homeless population living in the same urban area experienced an significant increased risk of SARS-CoV-2 infection ($|z|=3.65 > 1.96$).

Conclusion: These results highlight the need for organizing regular screening to prevent clusters forming in homeless accommodations and for providing basic resources for health maintenance.

Keywords: Homelessness; SARS-CoV-2; Health inequalities; seroprevalence; Housing conditions

Introduction

In 2016, nearly 5.3 million individuals (i.e., 2% of the population) had been without shelter, or in emergency or temporary accommodation at least once in their lifetime across Europe [1]. This surpassed previous estimates by far, which ranged from 0.1% to 0.3% across European countries [2,3]. The recent increase in the number of people experiencing homelessness is likely to further increase due to the current SARS-CoV-2 crisis.

Homeless people should be particularly vulnerable to SARS-CoV-2 infection: on the one hand, they cumulate risk factors for SARS-CoV-2 contamination, such as living in overcrowded or inadequate accommodations (squats, slums, or shared rooms in shelters), or having frequent contacts with people through community aid services (food distributions or day-care health facilities); on the other hand, they are at increased risks for severe SARS-CoV-2 disease, being exposed to a high prevalence of comorbidities, particularly respiratory and heart diseases, in addition to an ageing issue [4–7].

Previous literature has pointed out the challenge of providing care for the homeless during the SARS-CoV-2 pandemic [5] and reported explorations of SARS-CoV-2 prevalence using virological tests in one, three or five shelters [8–10], in particular in U.S. settings. Such explorations provided interesting clues on the environmental factors favouring the spread of SARS-CoV-2 transmission, such as moves among homeless accommodations, overcrowded and congregate settings, where physical distancing was challenging. To our knowledge, data from Europe are still lacking, as well as systematic assessments of the impact of the SARS-CoV-2 infection in the homeless population as a whole, on a city-wide scale rather than in specific living settings where public health teams responded to clusters.

In the present cross-sectional study, which is part of a broader population-based cohort study on morbidity and mortality due to SARS-CoV-2 among the homeless population named COVID-Homeless, our aims were: 1) to assess the seroprevalence of SARS-CoV-2 during the first wave of SARS-CoV-2 outbreak among the homeless population living in Marseille, the second most populated city of France and one of its poorest, which was also the second zone in France with active circulation of the virus at

the time of the study period [11]; 2) to compare seroprevalence estimates according to living conditions, sociodemographic and medical conditions in order to assess correlates of seroprevalence.

Materials and Methods

Study design, participants and sampling

The present cross-sectional seroprevalence study is part of a large prospective population-based cohort survey of homeless people living in Marseille, France ("COVID-Homeless"). Participants were enrolled between June 1 and August 5, 2020 from 48 different homeless spots in the city, including streets, slums, squats, emergency and transitional shelters, and drop-in centres. Eligible individuals were aged over 18 and lived in the following typology of homelessness (according to the ETHOS - European typology for homelessness and housing exclusion, which is a framework definition for policy and practice purposes stated at the European level) [12]: i) living rough (ETHOS1), ii) living in emergency accommodations (emergency shelters and hotels) (ETHOS2); iii) living in transitional accommodations for the homeless (ETHOS3); and iv) living in insecure accommodations (i.e., illegal occupation of lands, squat/slum or temporarily with family/friends) (ETHOS8). Participants signed a consent form to participate after having received information on the study's purposes, intended data use, and being ensured anonymity. All participants underwent a rapid serological test for SARS-CoV-2 IgM/IgG antibodies. A face-to-face questionnaire was also filled in using Redcap software (www.project-redcap.org) and including demographic characteristics, type of homelessness and history of accommodations since the SARS-CoV-2 outbreak, comorbidities (diabetes, cancer, chronic respiratory disease, cardiovascular pathology, hypertension, immunosuppression, or chronic renal failure) and prior or present symptoms of COVID-19. This study was approved by the local Research Ethics committee on May 28, 2020 (number 44-20) .

ClinicalTrials.gov ID: NCT04408131 on May 29, 2020

The 48 homeless settings were identified in partnership with all of the outreach teams from

public health and social services and community partners working in Marseille, France, and who participated in the enrolment phase (Figure 1). Register for homeless facilities of each outreach team and users' register of each enrolled facility during a time period were both considered in the study. There was no initial sampling since achieving exhaustiveness was the purpose of the COVID-Homeless study. Although comprehensive homelessness prevalence data for Marseille are still lacking, we used data from the local orientation system (SIAO) for emergency and transitional accommodations, and NGO estimations for slums/squats and streets: 775 in emergency shelters, 300 in hotels, 443 in transitional shelters, 840 in squats/slums and 400 as rough sleepers. These data did not include diffuse accommodation facilities (10 settings), family shelters (3 settings) or any children from squats since children were excluded from the study (i.e. an Ethics Board's decision). Given the potential refusals among the homeless population in enrolled facilities, we calculated a minimum sample size to be reached to achieve appropriate SARS-CoV-2 seroprevalence estimates [13]. A sample size of 430 from a population of 2,800 gave a two-sided 95% confidence interval with a precision (half-width) of 0.02 when the actual seroprevalence is near 0.05.

Insert Figure 1: Mapping locations of homeless people participating in the study, Marseille, France

Serology Testing

To assess the seroprevalence rates of SARS-CoV-2, we used validated serological tests manufactured by the French company Biosynex (Biosynex COVID-19 BSS) and providing, within 10 minutes the results on the presence of immunoglobulins M (IgM) and G (IgG). In the validation test phase, the serological assay showed sensitivity of 91.8% (95%CI: 83.8%-96.6%), specificity of 99.2% (95%CI: 97.7%-99.8%) for IgM antibodies (based on 456 samples) and 100% (95%CI: 96.1%-100%) and 99.5% (95%CI: 98.1%-99.9%), respectively, for IgG (based on 446 samples) (www.biosynex.com). An independent validation study carried out by the National Reference Centre (CNR Institute Pasteur and CNR associated laboratory of the Hospices Civils de Lyon) gave similar results (https://covid-19.sante.gouv.fr/tests).

Analysis

Descriptive analyses were presented as frequencies and percentages for categorical variables, and as means and standard deviations for quantitative variables. We estimated the SARS-CoV-2 seroprevalence as the proportion of individuals who had a positive result in the IgG or IgM band of the rapid serological test. Seroprevalence estimates were described as proportions with confidence intervals (95%CI). Bootstrap resampling approach with a set of 1,000 samples was used to create confidence intervals, accounting for variability in the sensitivity and specificity of the serological assay. Chi-2 or Fisher's exact test, and Wilcoxon rank-sum test were used to compare the proportion of positive SARS-CoV-2 tests among homeless typology, demographic groups, symptoms and comorbidities. Statistical analysis was performed using R version 3.6.0 software [14].

Results

Between June 1 and August 5, 2020, we enrolled 1,274 individuals, 1,156 of whom had complete data and were included in our analysis (Figure 2). The mean age was 40.2 (standard deviation: 14.3) years with 5.4% over 65 years old. The majority of respondents were men (71.3%), had lower secondary education level or no educational achievement (83.1%) and had health insurance coverage (70.3%), and among the latter 24.8% were covered by the state health insurance (Table 1). A large majority of respondents were foreign (81.3%) and were born abroad: 42.1% from African countries, 16.2% from European Union (EU) countries, 17.6% from European countries outside EU and 5.4% were from countries outside Africa and Europe. A maximum of 14% reported work activity at time of the survey (legal or illegal employment). A total of 348 (30.2%) participants were living in emergency shelters, 195 (16.9%) in hotel rooms, 192 (16.7%), in transitional shelters, 329 (28.5%) in squats/slums and 89 (7.2%) in the street (Table 1). One third (32.4%) reported long-term homelessness (>5 years) and one half (53.3%) reported having at least one comorbidity.

Insert Figure 2: Flow chart of the SARS-CoV-2 seroprevalence study among people experiencing homeless, Marseille, France

Table 1: Sociodemographic characteristics of the study population (n=1,156)

Sociodemographic characteristics	**n (%) or mean (SD)**	
Gender		
Men	824	(71.3%)
Women	332	(28.7%)
Age, year	40.2	(14.3)
French Nationality [a]	208	(18.1%)
Country of Birth[$,£]		
France	216	(18.7%)
European union	187	(16.2%)
Outside European union	203	(17.5%)
Africa	485	(42.0%)
Other	65	(5.6%)
Education attainment		
No educational achievement	529	(45.8%)
Lower secondary	431	(37.3%)
Upper secondary or vocational	123	(10.6%)
Don't know or missing	73	(6.3%)
Living with someone [b]	517	(45.2%)
Health insurance [c,$]	794	(70.3%)
State health insurance or other[$]		
State health insurance	197	(17.4%)
Other	597	(52.9%)
None	335	(29.7%)
Having financial resources		
No	497	(43.0%)
Yes	622	(53.8%)
Missing	37	(3.2%)
Having a working situation		
No	960	(83.1%)
Yes	159	(13.7%)
Missing	37	(3.2%)
Living conditions	**n**	(%)
Total length of homelessness		
<3 months	83	(7.2%)
3 to 12 months	228	(19.7%)
1 to 5 years	426	(36.9%)
>5 years	374	(32.4%)
Missing data	45	(3.9%)
Typology ETHOS* at baseline [$]		
ETHOS 1: street	89	(7.7%)
ETHOS 2: emergency shelters	348	(30.2%)
ETHOS2: hotel rooms	195	(16.9%)
ETHOS 3: transitional shelters	192	(16.7%)
ETHOS 8: squats, slums	329	(28.5%)
Type of accommodation		
Private room or area	504	(44.3%)
Shared room or area	634	(55.7%)
Change of accommodation during SARS_COV2 crisis		
No	686	(59.3%)
Yes	428	-37%

Missing	42	(3.6%)
Health characteristics	**n**	(%)
Tobacco consumption		
No	463	(40.1%)
Yes	608	(52.6%)
Missing	85	(7.4%)
Alcohol consumption		
none	766	(66.3%)
<3 glasses	135	(11.7%)
>=3 or more glasses	128	(11.1%)
Missing	127	-11%
Substance consumption		
No	850	(73.5%)
Yes	200	(17.3%)
Missing	106	(9.2%)
Comorbidities [d]		
Having at least one comorbidity (% yes)	617	(53.3%)
Number of comorbidities	1	(1.3)
Psychiatric and addiction comorbidities (% yes)	272	(23.5%)
Existence of risk factors for severe SARS-CoV-2 disease		
Obesity (% yes)	74	(6.5%)
Diabetes (% yes)	87	(7.7%)
Cancer (% yes)	23	(2.0%)
Chronic Respiratory Pathology (% yes)	92	(8.5%)
Cardiovascular Pathology (% yes)	147	(13.5%)
Chronic renal failure (% yes)	22	(2.0%)

a: the proportion of 'No French nationality' can be deduced; b: the proportion of 'Single individual' can be deduced; c: the proportion of 'No health insurance' can be deduced; d: the proportion of ‘no comorbidities' can be deduced. *ETHOS: the European typology for homelessness and housing exclusion. SD: standard deviation. $: missing data were less than 3% and were not reported. £: “European Union” countries: Belgium, Bulgaria, Germany, Hungary, Italy, Poland, Portugal, Romania, Czech Republic, Slovakia, and Spain. “Outside European Union” countries: Albania, Armenia, Bosnia, Croatia, Moldavia, Montenegro, Serbia, Russia including Chechenia, and Ukraine.

Table 2 shows the seroprevalence of SARS-CoV-2 in the study population. In this study, 58 of 1,156 were positive for SARS-CoV-2 IgG antibodies (5.0%); 24 of 1,156 were positive for SARS-CoV-2 IgM antibodies (2.1%); 17 (1.5%) were positive for both SARS-CoV-2 IgG and IgM antibodies. Overall, seroprevalence was 5.62% (95%CI: 2.90 – 7.21).

Table 2: Rapid serological testing results for SARS-CoV-2 (N=1,156)

	Seronegative cases n (%)		Seropositive cases n (%)		IC95% [$]
Rapid serological testing					
IgM	1132	(97.92%)	24	(2.08%)	(0.27 – 2.26)
IgG	1098	(94.98%)	58	(5.02%)	(3.13 – 5.20)
Seroprevalence	1091	(94.38%)	65	(5.62%)	(2.90 - 7.21)

IC95%: confidence interval at 95%; IgM/IgG: immunoglobulins M and G antibodies for SARS-CoV-2. $: Bootstrap resampling approach with a set of 1,000 samples was used to create 95% confidence intervals.

Seroprevalence was not statistically different between men and women, between people living with someone and living alone, between those with work activity and their counterparts (Table 3). No differences were found according to age, country of birth or level of education. Seroprevalence estimates were significantly different between ETHOS categories: 8.10% (95%CI; 5.89 – 10.63) in ETHOS 2 (i.e. emergency shelters and hotels), 3.95% (95%CI: 2.12 – 6.66) in ETHOS 8 (i.e. squats/slums), 3.12% (95%CI: 1.16 – 6.68) in ETHOS 3 (i.e. transitional shelters) and 2.25% (95%CI: 0.27 – 7.88) in ETHOS 1 (i.e. rough sleepers) (P = 0.009). Among homeless participants testing positive for SARS-CoV-2, 56.9% (37/65) had spent more than one month in emergency shelters, compared to 29.5% (313/1091) of participants with negative tests (P < 0001).

Table 3: Seroprevalence of SARS-CoV-2 by demographic, living conditions, health characteristics and comorbidities (N=1,156)

		Seronegative cases		Seropositive cases		IC95%	p
Demographic		N	(%)	N	(%)		
Sex							
	Men	780	(94.66%)	44	(5.34%)	(3.91 - 7.1)	0.572
	Women	311	(93.67%)	21	(6.33%)	(3.96 - 9.51)	
Age, year		40.1	(14.3)	42.2	(14.5)		0.271
French Nationality							
	No	882	(93.73%)	59	(6.27%)	(4.81 - 8.01)	0.067
	Yes	202	(97.12%)	6	(2.88%)	(1.07 - 6.17)	

Country of Birth[£]						
France	207	(95.83%)	9	(4.17%)	(1.92 - 7.76)	0.382
European Union	179	(95.7%)	8	(4.3%)	(1.86 - 8.26)	
Non-European union	194	(95.6%)	9	(4.4%)	(2.05 - 8.25)	
Africa	450	(92.78%)	35	(7.22%)	(5.08 - 9.89)	
Other	58	(93.55%)	4	(6.45%)	(1.79 - 15.7)	
Education attainment						
No educational achievement	504	(94.92%)	25	(4.71%)	(3.07 - 6.87)	0.420
Lower secondary	402	(91.78%)	29	(6.62%)	(4.48 - 9.37)	
Upper secondary or vocational	117	(95.12%)	6	(4.88%)	(1.81 - 10.32)	
Don't know or missing	68	(86.08%)	5	(6.33%)	(2.09 - 14.16)	
Living with someone						
No	592	(94.27%)	36	(5.73%)	(4.05 - 7.85)	0.795
Yes	490	(94.78%)	27	(5.22%)	(3.47 - 7.51)	
Health insurance						
No	322	(96.12%)	13	(3.88%)	(2.08 - 6.54)	0.122
Yes	743	(93.58%)	51	(6.42%)	(4.82 - 8.36)	
State health insurance or other						
State health insurance	184	(93.4%)	13	(6.6%)	(3.56 - 11.02)	0.227
Other	559	(93.63%)	38	(6.37%)	(4.54 - 8.63)	
None	322	(96.12%)	13	(3.88%)	(2.08 - 6.54)	
Having financial resources						
No	463	(93.15%)	34	(6.84%)	(4.78 – 9.42)	0.199
Yes	591	(95.01%)	31	(4.98%)	(3.41 – 6.84)	
Having a working situation						
No	899	(93.64%)	61	(6.35%)	(4.89 - 8.08)	0.065
Yes	155	(97.48%)	4	(2.51%)	(0.68 – 6.31)	
Living conditions						
Total length of homelessness						
<3 months	79	(92.94%)	4	(4.71%)	(1.3 - 11.61)	0.787
3 to 12 months	218	(94.78%)	10	(4.35%)	(2.1 - 7.85)	
1 to 5 years	399	(92.79%)	27	(6.28%)	(4.18 - 9)	
>5 years	353	(93.88%)	21	(5.59%)	(3.49 - 8.41)	
Typology ETHOS* at baseline						
ETHOS 1: street	87	(97.75%)	2	(2.25%)	(0.27 - 7.88)	**0.009**
ETHOS2: emergency shelters and hotels	499	(91.9%)	44	(8.1%)	(5.89 – 10.63)	
ETHOS 3: transitional shelters	186	(96.88%)	6	(3.12%)	(1.16 - 6.68)	
ETHOS 8: squats, slums	316	(96.05%)	13	(3.95%)	(2.12 - 6.66)	
Type of accommodation						
Private room or area	477	(93.9%)	27	(5.31%)	(3.53 - 7.64)	0.896
Shared room or area	598	(94.17%)	36	(5.67%)	(4 - 7.76)	
Time spent in emergency shelters						
Less than on month	747	(96.39%)	28	(3.61%)	(2.41 – 5.18)	**<0.0001**
More than one month	313	(89.43%)	37	(10.57%)	(7.55 – 14.28)	
Contacts per day, number	9.2	(12.2)	6.1	(5.9)		**0.001**
Change of accommodation during SARS-CoV-2 crisis						

	No	655	(95.48%)	31	(4.52%)	(3.09 - 6.35)	0.08
	Yes	398	(92.99%)	30	(7.01%)	(4.78 - 9.86)	
Health characteristics [g]							
Prior or present symptoms of SARS-CoV-2 disease							
	No	365	(90.12%)	40	(9.88%)	(7.15 – 13.21)	**<0.001**
	Yes	23	(53.49%)	20	(46.51%)	(31.18 – 62.35)	
Tobacco consumption							
	No	424	(91.58%)	39	(8.42%)	(6.06 - 11.34)	**<0.001**
	Yes	590	(97.04%)	18	(2.96%)	(1.76 - 4.64)	0
Alcohol consumption							
	No	717	(93.6%)	49	(6.40%)	(4.77 - 8.37)	0.047
	Yes	277	(96.85%)	9	(3.15%)	(1.45 - 5.89)	
Comorbidity							
	No	513	(95.18%)	26	(4.82%)	(3.17 - 6.99)	0.307
	Yes	578	(93.68%)	39	(6.32%)	(4.53 – 8.54)	
Number of comorbidities		1	(1.3)	1	(1.1)		0.749
Psychiatric and addiction comorbidities							
	No	827	(93.55%)	57	(6.45%)	(4.92 – 8.27)	**0.034**
	Yes	264	(97.06%)	8	(2.94%)	(1.28 – 5.71)	
Risk factors for severe SARS-CoV-2 disease							
Obesity							
	No	1000	(94.61%)	57	(5.39%)	(4.11 - 6.93)	0.594
	Yes	69	(93.24%)	5	(6.76%)	(2.23 - 15.07)	
Diabetes							
	No	1012	(94.4%)	60	(5.6%)	(4.3 - 7.15)	0.807
	Yes	79	(94.05%)	5	(5.95%)	(1.96 - 13.35)	
Cancer							
	No	1045	(94.74%)	58	(5.26%)	(4.02 - 6.74)	0.124
	Yes	20	(86.96%)	3	(13.04%)	(2.78 - 33.59)	
Chronic Respiratory Pathology							
	No	935	(94.35%)	56	(5.65%)	(4.3 - 7.28)	0.812
	Yes	88	(95.65%)	4	(4.35%)	(1.2 - 10.76)	
Cardiovascular Pathology							
	No	884	(94.24%)	54	(5.76%)	(4.35 - 7.45)	0.847
	Yes	140	(95.24%)	7	(4.76%)	(1.94 - 9.57)	
Chronic renal failure							
	No	1001	(94.34%)	60	(5.66%)	(4.34 - 7.22)	0.999
	Yes	21	(95.45%)	1	(4.55%)	(0.12 - 22.84)	

IC95%: confidence interval at 95%; SD: standard deviation. *ETHOS: the European typology for homelessness and housing exclusion. £: "European Union" countries: Belgium, Bulgaria, Germany, Hungary, Italy, Poland, Portugal, Romania, Czech Republic, Slovakia, and Spain. "Outside European

Union" countries: Albania, Armenia, Bosnia, Croatia, Moldavia, Montenegro, Serbia, Russia including Chechenia and Ukraine.

Seroprevalence was lower in participants who reported tobacco consumption (2.96% [1.76 – 4.64]) than in non-tobacco users (8.42% [6.06 – 11.34]) (P < 0.001) (Table 3). Seroprevalence was 2.2-fold lower in participants with psychiatric and/or addiction comorbidities (2.94% [(1.28 – 5.71]) than in their counterparts without psychiatric and/or addiction comorbidities (6.45% [4.92 – 8.27]) (P = 0.034). Almost half of the participants who had symptoms at the time of testing were SARS-CoV-2 seropositive compared to 6% among participants who reported no symptoms (P < 0.001)

Discussion

This study is the first attempt to quantify the seroprevalence of SARS-CoV-2 among homeless people using a systematic approach taking into account different community settings.

The most immediate and evident conclusion that can be drawn from this study is that the COVID-19 pandemic affected the surveyed population more than the French general population. A French seroprevalence study based on 12,000 national samples collected between May and June, 2020 reported a positivity rate of 4.5% on French territory and a positivity rate of 3.6% in Marseille [15]. At the same period, the prevalence for SARS-CoV-2 based on molecular testing was 1.3% on the French territory and 1.8% in the South-East region where Marseille is located [16]. In Marseille, existing official data on COVID-19 showed that the first case in the general population was diagnosed on March 3, 2020 and the epidemic remained active until the end of the study period, with an incidence rate > 70/100,000 inhabitants. Although our homeless population experienced an increased risk of SARS-CoV-2 infection compared to the general population, this population appears to have remained relatively unexposed to SARS-CoV-2, even in an area with widespread virus circulation. Public health measures like making tourist hotel rooms available, the decrease in density in emergency shelters, and testing campaigns including this study, probably contributed to preventing the spread of SARS-CoV-2 among the homeless population. Since social contacts are the means of propagation of SARS-CoV-2 infection, lower seroprevalence among homeless people living rough and among homeless people with psychiatric

disorders should be interpreted as a sign of exclusion of these particularly stigmatized people [17]. Qualitative research was performed in conjunction with the present epidemiology study, which revealed insights into how homeless people have strong individual and group health skills, but the availability of resources like water or safe, affordable housing prevented people from being able to protect themselves from the SARS-CoV-2 pandemic.

The second key finding from this study is that emergency shelters represented the greatest risk of SARS-CoV-2 exposure. With an estimated 8%, the seroprevalence among homeless people living in emergency shelters was twofold higher than the national seroprevalence survey (EPICOV) [15]. The results from this survey align with attempts to quantify over-exposure to SARS-CoV-2 in homeless people throughout other countries. Tobolowsky and colleagues reported prevalence data from three affiliated homeless shelters in Seattle, Washington, during the period March 30 – April 11, 2020. Among the 245 residents tested with a SARS-CoV-2 PCR assay with a nasopharyngeal swab, 18% had positive test results [10]. Baggett and colleagues reported results of prevalence of SARS-CoV-2 infection in residents of a large homeless shelter in Boston. Between March and April 2020, 408 residents were tested, among those 36% were positive for a SARS-CoV-2 PCR test [8]. Both studies recruited homeless shelters with a COVID-19 case cluster, which is a clear difference with our systematic approach. Similarly, SARS-CoV-2 seroprevalence studies from cohorts representing the general population or healthcare personnel have reported heterogeneous estimates from April to early May this year [18–23]. With mainly nationwide population-based cohort study, these studies found seroprevalence rates ranged from 1.0% in the San Francisco Bay area in April 2020, to 8.5% in the canton of Geneva in May 2020. However, as previously mentioned, these seroprevalence data collections were spread over a significant different time period, which makes comparable figures hard to find. While our results suggest that, lengths of stay in emergency shelters for homeless individuals should be as short as possible to minimize morbidity related to SARS-CoV-2, rapid access to affordable housing and support is too often missing and homeless people are still rotating between streets, shelters, squats, and hospital [24,25]. If housing resources are not mobilised, less overcrowded accommodations including a high social worker

workforce like in transitional shelters would appear to be more appropriate and safer to prevent exposure to a pandemic.

Our study led us to question the screening tests we used for this large homeless population. Methods of screening have progressed enormously in recent years with the availability of rapid tests that can be carried out for use at a community level [26,27]. As noted by WHO, "rapid serology tests, applied in the right situation for appropriate public health measures to be put into place, can make a huge difference" [28]. For SARS-CoV-2, rapid antibody and molecular testing were available from March 2020, with good to high sensitivity and specificity [29–32]. Detection of antibodies to SARS-CoV-2 takes a different approach to existing virological diagnosis approaches, aiming to assess the exposure of a broader population to a virus and to indicate that people were infected at some point since the start of the pandemic. For example, a large majority of our seropositive population did not report any prior or recent symptoms compatible with SARS-CoV-2 infection. This suggests that rapid serologic assays represent appropriate tools for homelessness services to help them discriminate against infection and put into place more effective public health measures in the homeless population, who are accustomed to living with symptoms associated with chronic diseases, and therefore possibly underestimate the symptoms of SARS-CoV-2 infection.

This study is a cross sectional study conducted as early as possible in the epidemic outbreak to inform public decision makers in supporting NGOs and local regional institutions maintaining strong efforts towards the homeless population. A second step was planned (on going) which will provide further data on seroconversion as well as determining at what seroprevalence rate the progression of the SARS-CoV-2 pandemic is increasing. These results contribute to highlight the need for organizing regular screening to prevent (rather than trace) clusters in homeless accommodations and for maintaining specific housing solutions for the homeless during the pandemic. These solutions must include re-housing, a ban on squat evictions and less populated settings with adequate prevention measures.

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