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Prevalence of SARS-CoV-2 infection and associated risk factors among asylum seekers living in asylum centres: A cross-sectional serologic study in Canton of Vaud, Switzerland

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ABSTRACT

Background: Understanding the factors influencing SARS-CoV-2 transmission in asylum seekers and refugees living in centres is crucial to determine targeted public health policies protecting these populations fairly and efficiently. In response, this study was designed to explore the pandemic's spread into asylum centres during the first wave of the pandemic in Switzerland. Specifically, it aimed to identify the risk factors associated with a positive anti-SARS-CoV-2 seroprevalence test after the first semi-confinement period (16 March to 27 April 2020) amongst asylum seekers and refugees living in centres.

Methods: This research is part of SérocoVID, a seroepidemiologic study of SARS-CoV-2 infection conducted in the canton of Vaud, Switzerland. Migrants living in two asylum centres, one known to have had an epidemic outbreak, were invited to participate in this study. Anti-SARS-CoV-2 IgG and IgA antibodies targeting the spike viral protein were measured in all participants using a Luminex immunoassay. Each participant also completed a questionnaire measuring socio-demographic characteristics, medical history (comorbidities, smoking status, BMI, flu-like symptoms), health literacy, public health recommendations (wearing a masque in a public area, social distancing and hands cleaning), behaviours and exposures (daily life activities, number of contacts weekly). The association of these independent variables with the serologic test result were estimated using a multivariable logistic regression model.

Findings: A total of 124 participants from the two asylum centres took part in the study (Centre 1, $n = 82$; Centre 2, $n = 42$). The mean participation rate was 36.7%. The seroprevalence in Centres 1 and 2 were 13% [95% CI 0.03, 0.14] and 50% [0.34, 0.65], respectively. Next, 40.63% of SARS-CoV-2 positive people never developed symptoms (asymptomatic cases), and no one had severe forms of the Covid-19 disease requiring hospitalisation. Participants report high compliance with public health measures, especially hygiene rules (96.3% of positive answers) and social distancing (88.7%). However, only 11.3% said they always wore a masque in public. After adjusting for individual characteristics, infection risk was lower amongst people with high health literacy (aOR 0.16, $p = 0.007$ [0.04, 0.60]) and smokers (aOR 0.20, $p = 0.013$ [0.06, 0.69]).

Conclusion: Despite the lack of severe complications of Covid-19 disease in this study, findings suggest that developing targeted public health measures, especially for the low health literacy population, would be necessary to limit the risk of outbreaks in asylum centres and improve this population's safety. Further investigations and qualitative approach are required to understand more finely how living conditions, risks and behaviours such as tobacco consumption, and the adoption of protective measures impact SARS-CoV-2 infection.

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1. Introduction

From the beginning of the Covid-19 pandemic, scientists and specialists alerted the additional danger that this epidemic could represent for migrant populations, especially asylum seekers (defined as people who have applied for asylum but whose procedure is still pending) and refugees (defined as people whose asylum application has been accepted by the host country). They also highlighted the need to consider social context and living conditions in managing and preventing the SARS-CoV-2 infection (Orcutt et al., 2020; Bhopal, 2020b; Kluge et al., 2020). Indeed, high population density, belonging to a minority ethnic group or social deprivation are risk factors for contracting SARS-Cov-2 infection (De Lusignan et al., 2020; de Souza et al., 2020; Rentsch et al., 2020). Thus, the International Organization for Migration (IOM), in a report published in December 2020, highlighted various vulnerability factors faced by forced migrant populations during this pandemic (Guadagno, 2020). They include in particular: social promiscuity and precarious living conditions promoting the virus's spread (Guadagno, 2020; Hayward et al., 2021; Clark et al., 2020), lower access to the healthcare system (Hayward et al., 2021; Clark et al., 2020; Page et al., 2020), including mental health care (Aragona et al., 2020), fear of legal repercussions (Clark et al., 2020), limited awareness of public health recommendation due to linguistic and cultural barriers (Guadagno, 2020; Clark et al., 2020) and underlying comorbidities (Guadagno, 2020; Clark et al., 2020; Greenaway et al., 2020). Before the Covid-19 pandemic, asylum seekers, refugees and undocumented migrants were already facing significant health inequities (Abubakar et al., 2018) and poorer access to care (Brandenberger et al., 2019). Thus, the Covid-19 pandemic appears to reinforce these populations' health inequities (Blukacz and Cabieses, 2020; Bhopal, 2020a; Mukumbang et al., 2020; Daniels, 2020; Bozorgmehr et al., 2020) and urge the need for adapted public health measures (Hayward et al., 2021; Alemi et al., 2020; Jozaghi and Dahya, 2020; Hargreaves et al., 2020; Valeriani et al., 2020).

The example of Singapore in the spring of 2020 illustrates the importance of not neglecting specific populations. While the public health authorities, through an effective screening and isolation system, had managed to contain the spread of the virus, many epidemic outbreaks occurred in unhealthy and overcrowded migrant worker households (Yi et al., 2021). Besides, a recent US community-based surveillance study carried out in 14 homeless shelters suggests that population density and sleeping arrangements (common room without separation *vs* single or shared room) are risk factors for SARS-CoV-2 infection (Rogers et al., 2021). These different studies confirm the importance of the housing and living conditions as risk factors for contamination and the risk of sharing a house with a positive case. Indeed, concerning migrant populations, many epidemic outbreaks have occurred in immigrant detention centres, notably in the United States (Erfani et al., 2021; Openshaw and Travassos, 2021). The scientific community has also warned on several occasions of the health challenges facing migrant populations living in centres in the context of the Covid-19 pandemic and of the need to adopt specific public health recommendations (Page et al., 2020; Garcini et al., 2020; Meyer et al., 2020; Douglas et al., 2020). Finally, a recent systematic review on clinical outcomes and risk factors for COVID-19 amongst migrant populations found that migrants are at increased risk of infection and advocated for better consideration of specific migrant groups such as migrants living in reception centres (Hayward et al., 2021).

Therefore, the management of the Covid-19 pandemic in asylum centres is a critical public health issue, both because of the high risk of outbreak clusters and the socio-economic health preconditions of its populations. A retrospective analysis based on national surveillance data in Greece highlighted a 2.5-to-3-time higher risk of COVID-19 infection amongst refugees and asylum seekers in reception facilities compared to the general population (Kondilis et al., 2021). However, to our knowledge, there are currently few prospective studies analysing the associated risk factors of SARS-CoV-2 transmission amongst asylum seekers living in asylum centres.

Understanding these risk factors is crucial to determine targeted public health policies protecting these populations fairly and efficiently. In response, this study was designed to explore the pandemic's spread into asylum centres (half-closed spaces) during the first wave of the pandemic in Switzerland. It aimed to identify the risk factors associated with the seroprevalence of SARS-CoV-2 infection after the first semi-confinement period (16 March to 27 April) amongst asylum seekers and refugees living in asylum centres.

2. Methods

2.1. Study design and participants

This research is a cross-sectional seroepidemiologic study of SARS-CoV-2 infection conducted in two asylum centres (Centre 1 and Centre 2) in the canton of Vaud (French-speaking region of Switzerland, 806′088 inhabitants on 31 December 2019) and is part of a nationwide program of SARS-CoV-2 seroprevalence in Switzerland (West et al., 2020). The study was launched between 4 May and 27 June 2020, coinciding with the easing of semi-confinement measures in Switzerland.[1]

The two centres are accommodation centres for people who have applied for asylum in Switzerland and whose application is either pending, provisionally accepted, accepted or rejected. We considered all residents of these centres as asylum seekers and refugees.

A venous blood sample was collected to proceed with serological testing. We collected additional information with a paper-version questionnaire in English and French. All participants (or their legal representative) provided written informed consent. The Cantonal Ethics Committee of Vaud, Switzerland (ID 2020–00,887) approved the protocol.

2.2. Procedures

The research team, in collaboration with the "Unité de soins aux migrants" (USMi)[2] of Unisanté (centre for Primary Care and Public Health) and the administrative team of the "Etablissement Vaudois d'Accueil des Migrants" (EVAM) ,[3] presented the study to the residents during visits to each of the two asylum centres.

The procedure was slightly different between the two centres for logistical reasons.

In Centre 1, investigators divided participants by language into small groups of 3 to 12 people and organised presentations of the study by groups of participants' languages in one of the centre's common rooms in the presence of a community interpreter. At the end of study presentation, people decided if they wanted to participate or not. Interpreters were also present to help with the completion of the questionnaires. Data collection and serology were carried out over ten days.

In Centre 2, in the absence of a room for group presentations, an invitation letter was sent to each participant. The letter summoned the participants on the day of the presence of the adapted community interpreter. An epidemic outbreak occurred in Centre 2 before the study.

The time taken to complete the questionnaire varied between 20 and 60 min, depending on the cases' complexity and the participants English or French comprehension.

[1] Closure of bars, restaurants, schools, services and non-essential shops. Ban on public and private meetings, mandatory home working.

[2] Specialized care units for the healthcare management of asylum seekers in the canton of Vaud, mostly composed of specialized nursing staff

[3] The EVAM is the institution mandated by the canton of Vaud to house, supervise and assist asylum seekers and provisionally admitted persons

2.3. Detection of anti-SARS-CoV-2 antibodies

We measured anti-SARS-CoV-2 IgG and IgA antibodies targeting the spike (S) protein using a Luminex immunoassay developed by the Lausanne University Hospital, Switzerland (Fenwick et al., 2020). The cut-off for a positive result was defined as a multiple immunofluorescence IgG or IgA antibody (MFI) ratio of ≥6. A venous blood sample was collected to proceed with serological testing.

2.4. Data

The outcome (dependant variable) was a positive IgG or IgA serological test. The independent variables were obtained from the answers to the questionnaires divided into five main categories.

1 Socio-demographic characteristics and health literacy

The questionnaire included items assessing Age *(in years)*, Gender (*male or female*), Education level *(no diploma, primary school, secondary school and university)*. Health literacy was assessed by a self-reported validated question (Sarkar et al., 2011) and coded into two categories *(high vs low)*.

1 Health conditions, clinical risk factors and symptoms

This section included questions assessing Smoking status *(non-smoker vs smoker)*, Comorbidities[4] *(No vs at least one)*, Body Mass Index (BMI) *(below vs above 30)*, Age *(More vs less than 65 years old)* and flu-like symptoms *(absence vs presence)*.

1 Living conditions and public health recommendations

This section included questions assessing Location *(centre 1 vs centre 2)*, Room *(single, two-people vs family room)*, Bathroom and Kitchen *(common vs private)*, Contact[5] *(0 vs one or more)*, Wearing a masque in public *(always, sometimes, never)*, Respecting social distancing[6] *(Yes, mostly yes, mostly no, no)* and Hygiene rules[7] *(Yes, mostly yes, mostly no, no)*

1 Behaviour and exposure

This section included questions assessing Meeting[8] *(0 to 5 vs more than five a week)*, Place of meeting *(kitchen, bathroom, living room, garden)*, Context of meeting *(Work, society game, sport, family, friends)* and Transport[9] *(public transport vs other)*.

2.5. Statistical analysis

First, we used a Chi-2 test to compare our sample with the entire population of Centres 1 and 2 according to age and sex categories using EVAM administrative data. Then, we used Odds ratios (OR) to measure the association between each of the four categories of independent variables and serology test result (bivariate analysis). From the bivariate analyses, we developed a multivariate logistic model, according to the method proposed by Hosmer and Lemeshow (2000), Bursac et al. (2008). We, first, selected all variable with a p-value <0.25 in the bivariate analysis, along with all variables of known clinical importance. Then, we tested the performance of different multivariate models obtained from the first selection using goodness-of-fit test (Hosmer-Lemeshow) and sensitivity/specificity analysis using the command "lstat" and "lroc". Lastly, we selected the best explanatory model to estimate the adjusted associations of living conditions, individual characteristics and behaviours with serologic test results (IgG or IgA seropositivity). We performed comparison with and without imputation of missing data, but no significant difference in the overall results were found. Hence, this paper is presented without imputation. Statistical analysis was performed using Stata/IC version 16.1.

3. Results

3.1. Sample size and representativeness

Amongst a total population of 338 people, 124 took part in the study (participation rate 36.7%), including 17 children under 12 (13.7%), 16 teenagers between 12 and 20 (12.9%) and 91 adults over 20 (73.4%), with a mean age of the adult sample of 35.8. Our sample is composed of 32 women (25.8%) and 92 men (74.2%). Lastly, 82 participants live in Centre 1 (66.1%) and 42 in Centre 2 (33.9%). (See **Supplementary File**) Based on the chi2 tests realised, there were no significant differences between our sample and the two asylum centres' whole population for the age categories and gender (See **Supplementary File**).

3.2. Socio-demographic characteristics and asylum centres

Table 1 presents the associations between serologic test and the socio-demographic characteristics (centre, age, gender, education level and health literacy). An unadjusted odds ratio (naOR) with its 95% confidence interval was calculated for each socio-demographic variable (column 3). There was a significant difference in seroprevalence between people living in Centre 1 and Centre 2 with a naOR of 6.46 [95% CI 2.69, 15.52] and between participants with low health literacy compared to participants with high health literacy with naOR of 2.60 [95% CI 1.02, 6.66].

3.3. Smoking status, clinical risk factors and symptoms

Table 2 presents the association between serologic test results, smoking status and clinical risk factors (comorbidities, BMI>30 kg/m^2, age>65 years).

Moreover, amongst people with a positive serologic test result, 40.6% never developed symptoms (asymptomatic cases). None of the participants had described clinical complications due to Covid-19 and

[4] We have only selected co-morbidities associated with an increased risk of complications of Covid-19 disease (Uncontrolled hypertension, uncontrolled diabetes, heart failure, history of heart attack or stroke, heart valve disease, impaired renal function, chronic respiratory disease, immune system weakness, cancer currently under treatment

[5] The question was: apart from the people living in the same room as you, how many people were you in close contact with (at less than 2 meters for more than 15 minutes) who had symptoms suggestive of COVID-19 (fever or cough or fatigue or out of breath or muscular pain or loss of tast/smell) while they were sick (or 48 hours before they were sick)?

[6] Respecting "social distancing" rules (avoid shaking hands or kissing, stay at home, avoid leaving your home unless absolutely necessary, etc.)

[7] Following simple hygiene rules (regular hand washing, sneezing into your elbow, using disposable tissues, etc.)

[8] The question was: during the confinement (March 16 to May 10), on average, how many people did you meet per week apart from the people living in the same room as you?

[9] This data is a combination of the two following questions: During the confinement (March 16 to May 10), what mode of transport did you use most of the time and what other mode of transport did you use? The answers were then dichotomized into public transport or other (car, bike, scooter, motorcycle, on foot)

Table 1
Association between serologic test results and socio-demographic characteristics.

Variables	*Seropositive (proportion)*	*Seronegative (proportion)*	*Non adjusted OR [95% CI]*	*(p-value)*
All sample (*n* = 124)				
Location				
Centre 1 (ref.)	11 (0.13)	71 (0.87)		
Centre 2	21 (0.50)	21 (0.50)	6.46 [2.69–15.52]	$p < 0.001$
Age (y)				
0–12	0 (0.00)	17 (1.00)	–	–
12–20 (ref.)[1]	5 (0.31)	11 (0.69)		
>20	27 (0.30)	64 (0.70)	0.93 [0.29–2.93]	$p = 0.899$
Gender				
Female (ref.)	6 (0.19)	26 (0.81)		
Male	26 (0.28)	66 (0.72)	1.71 [0.63–4.63]	$p = 0.293$
Only Adults and Teenagers (*n* = 107)				
Education				
No diploma (ref.)	2 (0.25)	6 (0.75)		
Primary school	8 (0.32)	17 (0.68)	1.41 [0.23–8.61]	$p = 0.708$
Secondary school	8 (0.26)	23 (0.74)	1.04 [0.17–6.26]	$p = 0.963$
University	10 (0.29)	25 (0.71)	1.20 [0.21–6.98]	$p = 0.839$
Health literacy[2]				
Low (ref.)	14 (0.39)	22 (0.61)		
High	11 (0.20)	45 (0.80)	0.38 [0.15, 0.98]	$p = 0.046$

[1] In the absence of positive cases amongst children aged 0–12 years, we limited the comparison between adolescents (12–20 years) and adults.
[2] Health literacy is measured by the question "Do you feel comfortable filling out a medical form on your own? (*i.e.* form with health questions when you go for the first time to see a doctor)" dichotomized into high *vs* low health literacy.

Table 2
Association between serologic test results and clinical risk factors or symptoms.

Variables	*Seropositive (proportion)*	*Seronegative (proportion)*	*Non adjusted OR [95% CI]*	*(p-value)*
Risk factors (*n* = 107)				
Smoking status[1]	22 (0.37)	36 (0.62)		
Non smoker (ref.)	10 (0.20)	39 (0.80)	0.42 [0.18, 1.01]	$p = 0.051$
Regular				
Comorbidities[2]	26 (0.29)	64 (0.71)		$p = 0.598$
No (ref.)	6 (0.35)	11 (0.65)	1.34 [0.45, 4.01]	
At least one				
BMI[3] *(y)*				
Below 30 (ref.)	27 (0.30)	64 (0.70)		
>30 (obese)	2 (0.25)	6 (0.75)	0.79 [0.15, 4.17]	$p = 0.781$
Symptoms				
Flu-like symptoms				
No (ref.)	13 (0.19)	57 (0.81)		
Yes	19 (0.51)	18 (0.49)	4.63 [1.92, 11.18]	$p = 0.001$

[1] We consider as regular smokers people who smoke at least one cigarette a week.
[2] We have only selected co-morbidities associated with an increased risk of complications of Covid-19 disease (Uncontrolled hypertension, uncontrolled diabetes, heart failure, history of heart attack or stroke, heart valve disease, impaired renal function, chronic respiratory disease, immune system weakness, cancer currently under treatment.
[3] Adult only.

did require hospitalisation.

3.4. Living conditions and public health recommendations

Table 3 describes the associations between a positive serological test and the living conditions of asylum seekers and refugees in the centres (single, double or family room, shared or in separate kitchen and bathroom). None of these living conditions was associated with a positive serological test. Table 3 also describes the associations between serological results and public health recommendations. Wearing a masque in public, respecting social distances and following hygiene rules were not associated with a decreased risk of a positive serological test result. While the respect of hygiene rules (96.26% of positive answers) and social distances (88.68%) is very high in our sample, only 11.32% of the participants wear always a masque in public, 53.77% sometimes and 34.91% never.

3.5. Behaviours and exposures

Table 4 summarises the main exposure places (common kitchen or bathroom, living room, garden, transports) and reasons of potential exposures (sport, friend, family, work) and their association with serological results. No significant associations were found.

3.6. Multivariable adjusted model

From the bivariate analyses, we developed a multivariable adjusted model (Table 5). The performance of the selected model are the following: area under ROC curve = 0.83. The sensitivity is 64.0% and the specificity 93.94%. In this adjusted model, three independent variables were associated with a lower risk of a positive serological test: living in Centre 1 (aOR 0.04 [0.01, 0.21]), high level of health literacy (aOR 0.16, [0.04, 0.60]) and active smoker status (aOR 0.20 [0.06, 0.69]).

4. Discussion

This cross-sectional seroepidemiological study is, to our knowledge, one of the first studies focusing on the risk factors associated with positive anti-SARS-CoV-2 serologic test amongst asylum seekers and refugees living in centres. It aimed at better understanding the individual and contextual risk factors for SARS-CoV-2 infection associated with living in an asylum centre.

First, our sample's high total seroprevalence, especially in Centre 2 -where a known epidemic outbreak occurred- confirm the challenge of managing this pandemic in asylum centres. It suggests that living conditions in community places and the associated social promiscuity require particular attention to limit viral transmission. Notably, these populations should have a priority access to testing and vaccination. Our data confirm other studies of community living populations.

Secondly, we highlighted that asylum seekers and refugees with a lower health literacy had an increased risk of SARS-CoV-2 infection than those with high health literacy, confirming a previous cross-sectional study analysing the association between health literacy and SARS-CoV-2 infection amongst outpatient department participants (Nguyen et al., 2020). Improving the health literacy of asylum seekers and refugees could, therefore, improve the implementation of public health responses (Wernly et al., 2020). In this epidemic context, it is necessary to consider people's health literacy and adapt public health messages and recommendations (Cangussú et al., 2020; McCaffery et al., 2020).

Thirdly, being an active smoker was, in our study, a protective factor. Confirming previous publications, active smokers seem to be protected against the risk of SARS-CoV-2 infection, possibly due to the specific

Table 3
Association between serologic test results and living conditions or public health recommendations.

Variables	Seropositive (proportion)	Seronegative (proportion)	Non adjusted OR [95% CI]	(p-value)
Living conditions				
Room				
Alone (ref.)	14 (0.29)	34 (0.71)		
Two-people room	15 (0.35)	28 (0.65)	1.30 [0.54, 3.15]	$p = 0.559$
Family room	3 (0.20)	12 (0.80)	0.61 [0.15, 2.49]	$p = 0.488$
Bathroom				
Private (ref.)	2 (0.18)	9 (0.82)		
No	30 (0.32)	65 (0.68)	2.08 [0.42, 10.21]	$p = 0.368$
Kitchen				
Private (ref.)	1 (0.13)	7 (0.87)		
No	31 (0.32)	66 (0.68)	3.29 [0.39, 27.90]	$p = 0.287$
Public health recommendations				
Contact[1] *(ppl)*				
0	23 (0.29)	57 (0.71)		
1 or more	8 (0.32)	17 (0.68)	1.17 [0.44, 3.08]	$p = 0.756$
masque[2]				
Always/sometimes	21 (0.30)	48 (0.70)		
No	11 (0.30)	26 (0.70)	0.97 [0.40, 2.31]	$p = 0.940$
Social Distancing[3]				
Yes/mostly yes	28 (0.30)	66 (0.70)		
No/mostly no	3 (0.25)	9 (0.75)	0.79 [0.20, 3.12]	$p = 0.732$
Hygiene rules[4]				
Yes/mostly yes	31 (0.30)	72 (0.70)		
No/mostly no	1 (0.25)	3 (0.75)	0.77 [0.08, 7.73]	$p = 0.828$

[1] The question was: apart from the people living in the same room as you, how many people were you in close contact with (at less than 2 m for more than 15 min) who had symptoms suggestive of COVID-19 (fever or cough or fatigue or out of breath or muscular pain or loss of tast/smell) while they were sick (or 48 h before they were sick)?.
[2] Wearing a masque in public.
[3] Respecting "social distancing" rules (avoid shaking hands or kissing, stay at home, avoid leaving your home unless absolutely necessary, etc.).
[4] Following simple hygiene rules (regular hand washing, sneezing into your elbow, using disposable tissues, etc.).

Table 4
Association between serologic test result and behaviours and exposures.

Variables	Seropositive (proportion)	Seronegative (proportion)	Non adjusted OR [95% CI]	(p-value)
Behaviours and exposures				
Meeting[1] *(ppl/week)*				
0–5 (ref.)	19 (0.30)	44 (0.70)		
>5	13 (0.30)	30 (0.70)	1.00 [0.43, 2.36]	$p = 0.994$
Kitchen				
No (ref.)	7 (0.21)	27 (0.79)		
Yes	25 (0.34)	48 (0.66)	2.01 [0.77, 5.26]	$p = 0.155$
Bathroom				
No (ref.)	17 (0.30)	39 (0.70)		
Yes	15 (0.29)	36 (0.71)	0.96 [0.42, 2.19]	$p = 0.915$
Living room				
No (ref.)	20 (0.27)	54 (0.73)		
Yes	12 (0.36)	21 (0.64)	1.54 [0.64, 3.70]	$p = 0.332$
Garden				
No (ref.)	15 (0.31)	34 (0.69)		
Yes	17 (0.29)	41 (0.71)	0.94 [0.41, 2.16]	$p = 0.883$
Society game				
No (ref.)	29 (0.32)	61 (0.68)		
Yes	3 (0.18)	14 (0.82)	0.45 [0.12, 1.69]	$p = 0.238$
Friends				
No (ref.)	23 (0.30)	55 (0.70)		
Yes	9 (0.31)	20 (0.69)	1.08 [0.43, 2.71]	$p = 0.877$
Family				
No (ref.)	29 (0.32)	63 (0.68)		
Yes	3 (0.20)	12 (0.80)	0.54 [0.14, 2.07]	$p = 0.372$
Sport				
No (ref.)	27 (0.29)	65 (0.71)		
Yes	5 (0.33)	10 (0.67)	1.20 [0.38, 3.90]	$p = 0.755$
Work				
No (ref.)	26 (0.30)	61 (0.70)		
Yes	6 (0.30)	14 (0.70)	1.01 [0.35, 2.91]	$p = 0.992$
Reduction meet				
Yes (ref.)	25 (0.29)	61 (0.71)		
No	5 (0.31)	11 (0.69)	1.11 [0.35, 3.52]	$p = 0.861$
Public Transport[2]				
Yes (ref.)	17 (0.24)	53 (0.76)		
No	11 (0.42)	15 (0.58)	2.29 [0.88, 5.92]	$p = 0.088$

[1] The question was: during the confinement (March 16 to May 10), on average, how many people did you meet per week apart from the people living in the same room as you?.
[2] This data is a combination of the two following questions: During the confinement (March 16 to May 10), what mode of transport did you use most of the time and what other mode of transport did you use? The answers were then dichotomized into public transport or other (car, bike, scooter, motorcycle, on foot).

infection mechanism of SARS-CoV-2 (Simons et al., 2020; Israel et al., 2020). However, this topic is controversial and recent data also highlighted a positive association between smoking status and infection's risk (Shastri et al., 2021; Hopkinson et al., 2021). Whereas the causal explanations of this link remain uncertain, meta-analyses have shown that smokers tend to develop more severe forms of the Covid-19 disease (Patanavanich and Glantz, 2020). Moreover, in our study, we suspected that active smokers were more protected due to their specific behaviour compared to non-smoker. Indeed, field observations suggested that they tend to be outside more often during the lockdown period to smoke. We need, however, new data, including ethnographic observation, to confirm this hypothesis. Finally, smoking is a significant public health issue amongst asylum seekers and refugees, as smokers' prevalence amongst these populations is high, as confirmed by our data (Amiri, 2020).

Fourthly, 40% of participants having a positive serologic result were asymptomatic and none of the individuals who contracted the virus required hospitalisation. It is probably due to the absence of older people (above 65 years old), the young mean age of the sample and the small number of participants with clinical risk factors for complications of Covid-19 infection. These data are consistent with the results of a rapid systematic review published in July 2021, suggesting a lower hospitalization rate amongst forcibly displaced populations (Hintermeier et al., 2021).

Fifthly, the application of standard health recommendations (wearing masks in public, hand, hygiene and social distancing) was not significantly associated with a higher protection in our study, highlighting the difficulty to implement properly public health measures in community centres. The higher Sars-CoV-2 seroprevalence amongst participants with low health literacy suggested that poor access to and understanding of adequate public health recommendations could partly explain this result. It also suggested the need for additional and adapted

Table 5
Multivariable logistic model (adjusted by age and gender).

Positive serologic test	*Adjusted OR [95% CI]*	*(p-value)*
Location (ref. : Centre 2)		
Centre 1	0.05 [0.01, 0.21]	$p<0.001$
Smoking status (Non-Smokers)		
Smokers	0.20 [0.06, 0.69]	$p = 0.011$
Wearing a masque in public (No)		
Yes	0.31 [0.08, 1.17]	$p = 0.085$
Health literacy (Low)		
High	0.16 [0.04, 0.60]	$p = 0.007$

public health measures to social (Alemi et al., 2020) and cultural context (Airhihenbuwa et al., 2020). This can also be explained by a potential desirability bias of the participants. Indeed, their self-reported compliance with health recommendations is particularly high in this sample.

However, all the results have to be cautiously interpreted due to the different limitations of this study and further research is needed to better determine how to implement public health recommendations in asylum centres and to understand how people negotiate the use of space practically, relationally and symbolically.

4.1. Limitations

This study has several limitations. First, the sample size and participation rate were small, limiting the collected data's statistical power. Besides, the high proportion of participants with a high level of education suggests a potential selection bias that could be explained by the lengthy questionnaire and potential language issues. Conducting studies with these populations remains a significant methodological and logistic challenge, explaining the low proportion of studies published to date. However, our sample did not statistically differ from the whole population of two centres regarding age and gender, reassuring this study's external validity. Other variables non identified in the survey could nevertheless have influenced the participation to the study. For example, asylum seekers having developed symptoms upstream of the study could have been more motivated to take part to a seroepidemiological study than asymptomatic asylum seekers. The goal of our study was, however, to assess the risk factors associated with a positive serological test result. It was not to compare the seroprevalence of asylum seekers with the seroprevalence of the general population. Thus, a potential overrepresentation of symptomatic participants does not influence the interpretation of the results regarding the risk factors associated with Sars-CoV-2 infection. Eventually, the presence of community interpreters and specialized nursing staff had ensured the participation of allophone and less integrated asylum seekers and refugees.

Another limitation lies in the cross-sectional design of the study. Indeed, it does not allow us to verify the evolution of the data over time or conclude causal relationships between seroprevalence and risk factors. Longitudinal research will be necessary to clarify the temporal association between seroprevalence and risk factors.

A third limitation concerns the presence of missing data. The large questionnaire size and the participants' language and cultural barriers probably explained the missing data for some questions. However, none of the variables analysed had more than 8% of missing data, and most variables had none at all.

Fourthly, the non-significant correlation between the results of serological tests and certain independent variables (especially public health recommendations) could be a result of the low variability of these variables within the sample population.

Fifthly, the choice of asylum centres was not made randomly. It is due to practical reasons linked to the pandemic context and the limited mobility possibilities induced by the public health measures. However, the choice of two of the largest centres in the Canton of Vaud guarantees a certain external validity to the study.

5. Conclusion

While the Covid-19 pandemic has highlighted and reinforced health inequities between different population categories worldwide (Bambra et al., 2020), this study confirms the social vulnerability of populations living in asylum centres. It also illustrates the need to adapt public health measures to them, considering the social promiscuity, the low health literacy and the difficulty of strictly adhering to health recommendations. Despite the absence of severe complications of the Covid-19 disease, developing targeted public health measures, including priority access to vaccination, would be necessary to limit the risk of epidemic clusters in asylum centres and improve this population's safety.

Further analyses are required to understand better the global consequences of the Covid-19 pandemic amongst migrant populations living in asylum centres. Areas of future work should include the analysis of socio-economic and psychological impacts of the pandemic, the role of the health literacy, linguistic and cultural barriers in the spread of the SARS-CoV-2 virus and its health consequences.

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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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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jmh.2023.100175.

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