Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Journal of Infection 85 (2022) e40–e43

Contents lists available at ScienceDirect

Journal of Infection

journal homepage: www.elsevier.com/locate/jinf

Letter to the Editor

SARS-CoV-2 seroprevalence in the adult detainees of the Paris area in 2021: A multicenter cross-sectional study

Dear Editor,

We read with interest the article by Whitaker et al. reporting the sociodemographic disparities in COVID-19 seroprevalence across England.[1] The value of serology is the assessment of exposure to SARS-CoV-2 over a long period of time; in contrast, PCR provides only a snapshot of infection at a given time point. In the COVIDET study (ClinicalTrials.gov NCT04516512), we evaluated the seroprevalence to SARS-CoV-2 in a representative sample of detainees in all penitentiary establishments of the Paris area. Indeed, promiscuity and overcrowding in prisons are risk factors for the transmission of infectious diseases, particularly viral respiratory diseases. On January 6, 2020, France had 70,651 people detained for 61,080 places.[2] To reduce the risk of exposure of inmates to SARS-CoV-2, French authorities have implemented measures such as stopping inmate activities outside of cells, suspending visiting hours, early release, and reducing the number of arrivals. As a result, the number of inmates in French prisons decreased by 6266 people between March 16 and April 1, 2020.

To date, there is little data on the SARS-CoV-2 seroprevalence in detainees and our study is, to our knowledge, the first in Europe. Reliable data on the extent of the COVID-19 epidemic in prisons are nevertheless necessary for the implementation of specific public health measures in this setting. This multicenter cross-sectional study was performed in the Paris area (formally, Île-de-France region) from January to July 2021. Participants were selected from the lists of the 11,413 men and women aged 18 to 80 detained on January 6, 2021 in the 12 penitentiary establishments (16 wards) of the Paris Area. Because of their lower number, all women were invited to participate in the study while a random sampling stratified on the 12 male detention wards was conducted for men.

Of 11,413 men and women detained in the Paris area on January 6, 2021, 3545 were invited to participate (3100 men and 445 women) and 1044 were included from January 14 to July 8, 2021; 2501 were not included, the main reasons being refusal to participate ($n = 920$) and release or transfer to another ward ($n = 803$). After inclusion, 30 participants were excluded from the analysis, the main reason being missing blood sample ($n = 25$). The analyzed population included 816 men and 198 women (mean age, 36.3 and 35.7 years, respectively). Sixty-six (6.5%) inmates reported COVID-19 vaccination.

Elecsys® Anti-SARS-CoV-2 N and Elecsys® Anti-SARS-CoV-2 S immunoassays (Roche Diagnostics, Mannheim, Germany) were used for the qualitative detection of anti-nucleoprotein antibodies and quantitative determination of anti-spike protein receptor binding domain antibodies, respectively.

Overall, 187 participants (18.4%; 95% CI, 16.1 to 20.8) were seropositive for SARS-CoV-2. After marginal calibration, this rate was 18.2% (95% CI, 16.9 to 19.4): 18.6% (95% CI, 17.2 to 19.9) in men and 15.2% (95% CI, 11.9 to 18.6) in women. The estimated seroprevalence rate during the inclusion period increased from 13.1% for the first 200 participants (January 14 to February 4, 2021) to 21.6% for the last participants (April 21 to July 8, 2021) (Fig. 1). For the week of February 8–14, 2021, the seroprevalence rate for SARS-CoV-2 in the general population of the Paris area was 20.6% (95% CI, 16.6 to 24.9) (3). For a comparable period (February 5–19, 2021), this rate was 18.4% (95% CI, 16.8 to 20.1) in our study. Therefore, the seroprevalence rate in detainees of the Paris area appeared comparable to that of the population in the same geographic area. It should be noted, however, that these two populations have different characteristics and direct comparison of prevalence rates must therefore be cautious.

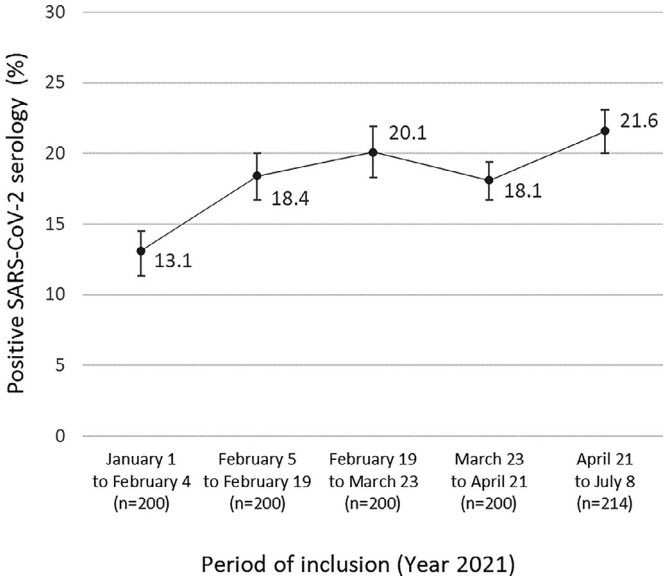

Fig. 1. Estimation (after marginal calibration on age and sex) of SARS-CoV-2 seroprevalence rates during the inclusion period.

Factors known or suspected to be related to SARS-CoV-2 infection and the occurrence of moderate to severe forms of COVID-19 were compared in SARS-CoV-2 seropositive and seronegative participants during the inclusion period, stratified on sex (Table 1). According to multivariate analysis, lower number of cigarettes per day ($p < 0.0001$) and higher number of inmates per cell ($p = 0.0008$) were independent factors significantly associated to SARS-CoV-2 seropositivity in male inmates. In female inmates, younger age ($p = 0.0002$) and lower number of cigarettes per day ($p = 0.0216$) were independent factors significantly associated to SARS-CoV-2 seropositivity.

https://doi.org/10.1016/j.jinf.2022.05.032

Table 1
Factors known or suspected to be related to SARS-CoV-2 infection and the occurrence of moderate to severe forms of COVID-19.

	Men			Women		
	SARS-CoV-2 serology		P-value	SARS-CoV-2 serology		P-value
	Positive ($N = 155$)	Negative ($N = 661$)		Positive ($N = 32$)	Negative ($N = 166$)	
Demographics						
Age, years, mean (SD)	34.5 (12.9)	36.7 (12.9)	0.0330	28.2 (10.7)	37.2 (12.5)	<0.0001
Smoker, n (%)	74 (47.7)	435 (66.1)	<0.0001	14 (43.7)	88 (53.0)	0.3371
Number of cigarettes per day, mean (SD)[a]	4.0 (6.1)	7.1 (7.5)	<0.0001	3.5 (5.8)	7.5 (10.0)	0.0688
Age of smoking start, years, mean (SD)	18.7 (8.3)	17.2 (6.2)	0.1434	16.6 (3.9)	16.3 (6.1)	0.4549
Comorbidities						
Number of comorbidities, n (%)						
0	136 (87.7)	570 (86.5)	0.4174	25 (78.1)	133 (80.1)	1.0000
1	16 (10.3)	83 (12.6)		6 (18.8)	30 (18.1)	
2	3 (1.9)	6 (0.9)		1 (3.1)	3 (1.8)	
Obesity (BMI > 30 kg/m^2), n (%)	9 (5.8)	70 (10.6)	0.0699	4 (12.5)	36 (21.7)	0.2360
Symptoms since March 2020, n (%)						
Fever or feeling of fever	34 (21.9)	71 (10.8)	0.0002	5 (15.6)	8 (4.8)	0.0399
Chills	20 (12.9)	59 (9.0)	0.1366	4 (12.5)	6 (3.6)	0.0584
Cough	26 (16.8)	93 (14.1)	0.4028	4 (12.5)	14 (8.4)	0.5006
Nasal discharge/rhinitis	17 (11.0)	106 (16.1)	0.1080	3 (9.4)	18 (10.8)	1.0000
Breathing discomfort/unusual breathlessness	17 (11.0)	43 (6.5)	0.0544	2 (6.2)	7 (4.2)	0.6402
Asthenia, fatigue	27 (17.5)	81 (12.3)	0.0858	6 (18.7)	25 (15.1)	0.5986
Muscle pain	20 (13.0)	54 (8.2)	0.0635	3 (9.4)	19 (11.4)	0.7779
Headache	25 (16.2)	87 (13.2)	0.3292	7 (21.9)	16 (9.6)	0.0668
Sore throat	11 (7.1)	44 (6.7)	0.8394	3 (9.4)	11 (6.6)	0.7042
Loss or reduction of smell	27 (17.5)	32 (4.9)	<0.0001	4 (12.5)	7 (4.2)	0.0813
Loss of taste	28 (18.2)	30 (4.6)	<0.0001	5 (15.6)	4 (2.4)	0.0064
Nausea/vomiting	4 (2.6)	29 (4.1)	0.3059	1 (3.1)	8 (4.8)	1.0000
Diarrhea	5 (3.2)	39 (5.9)	0.1860	0	8 (4.8)	0.3587
Conjunctivitis	3 (1.9)	12 (1.8)	1.0000	0	4 (2.4)	0.6143
Skin rash	1 (0.6)	18 (2.7)	0.1482	0	3 (1.8)	1.0000
COVID-like syndrome[b]	40 (25.8)	107 (16.2)	0.0050	6 (18.7)	22 (13.2)	0.5806
Pulmonary presentation[c]	21 (13.6)	50 (7.5)	0.0174	2 (6.2)	3 (1.8)	0.1848
Gastrointestinal presentation[d]	8 (5.2)	56 (8.5)	0.1676	1 (3.1)	14 (8.4)	0.4732
Peripheral neurological presentation[e]	28 (18.1)	41 (6.2)	<0.0001	6 (18.7)	7 (4.2)	0.0084
Social interactions and activities						
Number of inmates per cell, mean (SD)	1.9 (0.7)	1.8 (0.6)	0.0013	1.6 (0.5)	1.8 (1.0)	0.5062
Number of sick co-inmates, n (%)						
0	71 (56.3)	295 (67.4)	0.0005	14 (73.7)	69 (69.0)	0.5251
1	21 (16.7)	26 (5.9)		2 (10.5)	5 (5.0)	
2	34 (27.0)	117 (26.7)		3 (15.8)	26 (26.0)	
Meeting with sick personnel, n (%)						
0	35 (22.6)	134 (20.4)	0.8289	8 (25.0)	46 (27.9)	0.0409
1	35 (22.6)	152 (23.1)		1 (3.1)	33 (20.0)	
2	85 (54.8)	372 (56.5)		23 (71.9)	86 (52.1)	
Work, n (%)	81 (52.3)	321 (48.9)	0.4565	16 (50.0)	107 (64.8)	0.1124
Learning activities, n (%)	16 (10.3)	123 (18.7)	0.0123	9 (28.1)	50 (30.3)	0.8055
Parlor, n (%)	91 (58.7)	379 (57.8)	0.8320	17 (53.1)	96 (58.2)	0.5966
Walk, n (%)	144 (92.9)	588 (89.6)	0.2170	31 (96.9)	146 (88.5)	0.2080
Library, n (%)	24 (15.5)	159 (24.2)	0.0190	18 (56.2)	72 (43.6)	0.1899
Judicial extraction, n (%)	76 (49.0)	362 (55.2)	0.1670	12 (37.5)	74 (44.8)	0.4430
Medical appointments, n (%)	110 (71.0)	438 (66.8)	0.3151	28 (87.5)	135 (81.8)	0.4363
Sport, n (%)	68 (49.6)	326 (53.4)	0.4199	11 (34.4)	85 (51.5)	0.0759
At least one activity, n (%)	153 (98.7)	654 (98.9)	1.000	32 (100)	164 (98.8)	1.000

BMI, body mass index.
[a] Calculated with zero cigarette per day for non-smokers.
[b] (Fever or chills) and (asthenia or muscle pain or headache).
[c] Fever and (cough or dyspnea).
[d] Diarrhea or nausea or vomiting.
[e] Loss of smell or reduction of taste.

The preventive measures that were quickly implemented in French prisons could explain, at least in part, the comparable seroprevalence rates in detainees and in the population in the same geographic area. Indeed, as soon as the pandemic started, the French health authorities ordered the massive release of detainees and the suspension of visits and activities within the prisons. Communication was quickly set up concerning the barrier measures and masks as well as hydro-alcoholic gel were made available to inmates and staff. Although it is difficult to conclude a causal relationship between these actions and the number of COVID-19 cases, French prisons did not experience the outbreaks that have been reported in some prisons abroad.[4,5] Large-scale extrication is a strategy recommended by health experts to prevent Covid-19 cases among incarcerated individuals and staff.[4] It is likely that SARS-CoV-2 infection in French prison would have been more frequent in the absence of extrication, the value of which has been shown by US studies.[6,7] We observed that a higher number of inmates per cell was an independent factor significantly associated with SARS-CoV-2 seropositivity, thus supporting that overcrowding is a risk factor of COVID-19 infection.

To explain the differences observed between countries and between prisons, it is also necessary to take into account some specific characteristics of detention, such as circulation inside the prison and eating together or in cells. In a Quebec study, the consumption of meals shared with fellow inmates or with the sector significantly increased seropositivity compared to eating alone.[8] In France, all detainees take their meals in their cells, thus limiting circulation outside the cells.

In conclusion, the seroprevalence of SARS-CoV-2 in the prisons of the Paris area appeared comparable to the general population, most probably due to the early massive release of detainees and preventive barrier measures. Limiting incarceration and promoting usual infection control measures are important factors for controlling the COVID-19 epidemic in prison.

Funding

Sponsored by Assistance Publique-Hôpitaux de Paris (AP-HP) and funded by Agence Régionale de Santé Ile-de-France (ARSIdF), Agence Nationale pour la Recherche (ANR), Fondation de France, Société de Pathologie Infectieuses de Langue Française (SPILF) and Direction de l'Administration Pénitentiaire (DAP).

The sponsor and funders had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; or decision to submit the manuscript for publication.

Declaration of Competing Interest

There are no competing interests.

Data sharing statement

The datasets analyzed during the current study are available from the corresponding author on reasonable request.

Ethics

The study conformed to the principles of the Declaration of Helsinki and Good Clinical Practice Guidelines. It was approved by a national independent Ethics Committee ("Comité de Protection des Personnes, CPP Ile-de France VI"). Written informed consent was obtained from each patient.

CRediT authorship contribution statement

Guillaume Mellon: Conceptualization, Funding acquisition, Investigation, Project administration, Supervision, Writing – original draft, Writing – review & editing. **Alexandra Rouquette:** Conceptualization. **Catherine Fac:** Investigation. **Béatrice Carton:** Investigation. **François Cordonnier:** Investigation. **Emmanuelle David:** Investigation. **Béatrice Goutte:** Investigation. **François Heulin:** Investigation. **Valérie Kanoui:** Investigation. **Ludovic Levasseur:** Investigation. **Pascale Racle:** Investigation. **Benjamin Silberman:** Investigation. **Kawther Nehri:** Methodology. **Anne Dulioust:** Conceptualization, Funding acquisition, Writing – original draft, Writing – review & editing. **Anne-Marie Roque-Afonso:** Conceptualization, Writing – review & editing.

References

1. Whitaker H, Tsang RSM, Button E, Andrews N, Byford R, Borrow R, et al. Sociodemographic disparities in COVID-19 seroprevalence across England in the Oxford RCGP primary care sentinel network. *J Infect* 2022.
2. Ministere de la Justice. *Statistique trimestrielle des personnes écrouées en France*http://www.justice.gouv.fr/art_pix/Trim_2001.pdf.
3. Géodonnées en Santé Publique (GEODES). Séroprévalence du SARS-CoV-2 (%) 2021–06. https://geodes.santepubliquefrance.fr/#c=indicator&i=seroprev_sarscov_reg.seroprevalence_sarscov2&s=2021-06&t=a01&view=map1.
4. Barsky BA, Reinhart E, Farmer P, Keshavjee S. Vaccination plus decarceration - stopping COVID-19 in jails and prisons. *N Engl J Med* 2021;**384**:1583–5.
5. Lemasters K, McCauley E, Nowotny K, Brinkley-Rubinstein L. COVID-19 cases and testing in 53 prison systems. *Health Justice* 2020;**8**:24.
6. Vest N, Johnson O, Nowotny K, Brinkley-Rubinstein L. Prison population reductions and COVID-19: a latent profile analysis synthesizing recent evidence from the texas state prison system. *J Urban Health* 2021;**98**:53–8.
7. Reinhart E, Chen DL. Association of jail decarceration and anticontagion policies with COVID-19 case growth rates in US counties. *JAMA Netw Open* 2021;**4**:e2123405.
8. Kronfli N, Dussault C, Maheu-Giroux M, Halavrezos A, Chalifoux S, Sherman J, et al. Seroprevalence and risk factors for SARS-CoV-2 among incarcerated adult men in Quebec. *Clin Infect Dis* 2021:2022.

Guillaume Mellon*
EPSNF, Service de Médecine Polyvalente et Maladies Infectieuses, Hôpital de Fresnes, Fresnes 94260, France
AP-HP, Assistance Publique-Hôpitaux de Paris, COREB, Hôpital Bichat, Paris 75018, France

Alexandra Rouquette
AP-HP, Assistance Publique-Hôpitaux de Paris, Service d'Epidémiologie et de Santé Publique, Hôpital Bicêtre, Le Kremlin-Bicêtre, France
UVSQ, Inserm, CESP, Paris-Saclay University, Paris, France

Catherine Fac
AP-HP, Assistance Publique-Hôpitaux de Paris, Unité sanitaire en milieu pénitentiaire (USMP), Centre Pénitentiaire de Fresnes, Hôpital Bicêtre, Le Kremlin-Bicêtre, France

Béatrice Carton
Unité sanitaire en milieu pénitentiaire (USMP), Centre Pénitentiaire de Bois d'Arcy, Hôpital André Mignot, Le Chesnay, France

François Cordonnier
Unité sanitaire en milieu pénitentiaire (USMP), Centre Pénitentiaire de Poissy, Hôpital de Poissy, Poissy, France

Emmanuelle David
Unité sanitaire en milieu pénitentiaire (USMP), Centre Pénitentiaire de Meaux, Grand Hôpital de l'Est Francilien, Meaux, France

Béatrice Goutte
Unité sanitaire en milieu pénitentiaire (USMP), Centre Pénitentiaire d'Osny, Hôpital de Pontoise, Pontoise, France

François Heulin
Unité sanitaire en milieu pénitentiaire (USMP), Centre Pénitentiaire de Nanterre, Centre d'accueil et de soins hospitalier de Nanterre, Nanterre, France

Valérie Kanoui
Unité sanitaire en milieu pénitentiaire (USMP), Centre Pénitentiaire de Fleury-Mérogis, Centre hospitalier sud francilien, Corbeil-Essonnes, France

Ludovic Levasseur
Unité sanitaire en milieu pénitentiaire (USMP), Centre Pénitentiaire de Villepinte, Hôpital Robert Ballanger, Villepinte, France

Pascale Racle
Unité sanitaire en milieu pénitentiaire (USMP), Centre Pénitentiaire de Melun, Groupe Hospitalier Sud Ile de France, Melun, France

Benjamin Silberman
AP-HP, Assistance Publique-Hôpitaux de Paris, Unité sanitaire en milieu pénitentiaire (USMP), Centre Pénitentiaire de Paris, Hôpital Cochin, Paris, France

Kawther Nehri
Unité de Recherche Clinique, AP-HP, Hôpital Antoine Béclère, Clamart, France

Anne Dulioust
EPSNF, Service de Médecine Polyvalente et Maladies Infectieuses, Hôpital de Fresnes, Fresnes 94260, France

Anne-Marie Roque-Afonso
Université Paris Saclay, INSERM 1193, AP-HP, Service de virologie, Hôpital Paul Brousse, Villejuif 94800 France

*Corresponding author at: EPSNF, Service de Médecine Polyvalente et Maladies Infectieuses, Hôpital de Fresnes, Fresnes 94260, France
E-mail address: guillaume.mellon@aphp.fr (G. Mellon)