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Corresponding author:
Lucas Alves da Mota Santana;
Email: lucassantana.pat@gmail.com.

Neutralizing Antibodies Response for SARS-CoV-2 Among Young Inmates and Staff From a Juvenile Offender Institution in Brazil

Lysandro Pinto Borges PhD[1], Sarah Cristina Fontes Vieira PhD[2], Ricardo Queiroz Gurgel PhD[2], Breno de Mello Silva PhD[3], Cyntia Silva Ferreira PhD[3], Samara Mayra Soares Alves dos Santos MSc[3] and Lucas Alves da Mota Santana MSc[4,5]

[1]Department of Pharmacy, Federal University of Sergipe (UFS), São Cristóvão, SE, Brazil; [2]Department of Medicine and Graduate Program in Health Sciences, Federal University of Sergipe (UFS), Aracaju, SE, Brazil; [3]Department of Biological Sciences, Federal University of Ouro Preto (UFOP), Ouro Preto, MG, Brazil; [4]Department of Dentistry, Federal University of Sergipe (UFS), Aracaju, SE, Brazil and [5]Graduate Program in Dentistry, Federal University of Sergipe (UFS), Aracaju, SE, Brazil

The incarcerated population's vulnerability has been a concern worldwide since the beginning of the coronavirus disease 2019 (COVID-19) pandemic.[1] Crowding and health vulnerability are high risks of virus transmission in carceral settings, in which each inmate could contaminate up to 10 others.[2] In a maximum-security penitentiary complex in Brasília, 1 infected individual contaminated approximately 1057 inmates and staff within only 12 d.[3] Social isolation would be an effective measure to prevent virus transmission, but Brazilian prison systems have occupancy rates around 170%, poor ventilation, and shared bathrooms.[4,5] Brazil registers the third-largest prison population globally, with 690,000 inmates of which approximately 17,000 are adolescents confined in juvenile offender institutions.[6]

Although a lack of priority in the vaccination of prisoners has been reported in the literature,[7] Brazilian inmates are part of the priority groups in the Ministry of Health National Plan of Operationalization for Vaccination against COVID-19, and their mass immunization started in Sergipe state, Brazil, in January 2021. To date, there are no studies evaluating young inmate's risk in juvenile offender institutions, but once COVID-19 can be introduced in these places through staff and visitors, it is necessary to analyze the efficiency of immunization in these individuals. To investigate this, an evaluation of neutralizing antibodies' immune response among residents and staff in a juvenile offender institution after vaccination were performed.

Methods

Data from all residents and staff of "Renascer" Foundation were collected: the sociodemographic profile, vaccination status, presence of comorbidities, previous signs/symptoms of COVID-19, recognized exposure to COVID-19, serology for COVID-19 (Table 1), and total neutralizing antibodies (Table 2). "Renascer" Foundation is a juvenile offender institution in Aracaju, Sergipe state, Brazilian northeast, that shelters delinquent adolescents for a minimum duration of 2 y. The principles of the Declaration of Helsinki were followed and approved by the National Bioethics Committee of Brazil (**CAAE** 31018520.0.0000.5546).

Results and Discussion

Residents and staff were interviewed, and then their blood samples were collected for immunoglobulin (Ig) M and IgG serological testing for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) by the fluorescence immunoassay method 30 d after the first vaccine doses. Cutoff points considered for antibody levels were: positive $\geq$ 1.2 COI (cutoff index), and negative < 0.9 COI. Neutralizing antibody function (Kit Ichroma^{TM} COVID-19 nAb) was performed to evaluate sample antibodies binding on SARS-CoV-2 spike protein with ECA2 receptor. Cutoff points considered for neutralizing antibodies testing were negative <30% and positive ≥30%.

Of the 82 young inmates and 38 employees analyzed from Renascer Foundation, all residents were male (100%), as were most of the staff (73.68%). In Brazil, the prison population is commonly composed of black-brown individuals who have only completed elementary school or are illiterate.[8] Accordingly, in Renascer Foundation, 2.4% are illiterate young inmates, and 86.6% had only completed primary education, in addition to 70.7% of black-brown individuals.

The average age of young inmates was 17.66 y and that of staff was 40.03. Systemic arterial hypertension was the disease reported among staff with a significant difference among

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Table 1. Sociodemographic profile, vaccination status, comorbidity, previous signs/symptoms of COVID-19, recognized exposure to COVID-19, and serological status of young inmates and staff of the Renascer Foundation in Aracaju/Sergipe, Brazil*

General data of the population evaluated	Resident (%)	Staff	P-Value[a]
Age, *Mean (SD)*	17.66 (1.58)	40.03 (6.17)	<0.001[M]
Gender, *n (%)*			
Male	82 (100)	28 (7.,7)	<0.001[F]
Female	0 (0)	10 (26.3)	
Color self-view, *n (%)*			
White	24 (29.3)	4 (10.5)	0.066[Q]
Brown	33 (40.2)	17 (44.7)	
Black	25 (30.5)	17 (44.7)	
Level of education, *n (%)*			
Unlettered	2 (2.4)	0 (0)	<0.001[Q]
Primary	71 (86.6)	2 (5.3)	
Secondary	0 (0)	15 (39.5)	
Tertiary incomplete	9 (11)	6 (15.8)	
Tertiary complete	0 (0)	15 (39.5)	
Comorbidities			
Chronic respiratory disease, *n (%)*	5 (6.1)	1 (2.6)	0.663[F]
Circulation disease, n (%)	1 (1.2)	0 (0)	1.000[F]
HIV, *n (%)*	1 (1.2)	0 (0)	1.000[F]
Obesity, *n (%)*	0 (0)	1 (2.6)	0.317[F]
Systemic arterial hypertension, *n (%)*	0 (0)	9 (23.7)	<0.001[F]
Diabetes, *n (%)*	0 (0)	3 (7.9)	0.030[F]
IgM antibodies (COI), *Mean (SD)*	1.74 (1.72)	0.75 (1.42)	<0.001[M]
IgG antibodies (COI), *Mean (SD)*	7.44 (7.88)	8.41 (9.20)	0.927[M]
Covid-19 vaccination, *n (%)*			
First dose	43 (52.4)	9 (23.7)	0.002[Q]
Two doses	0 (0)	2 (5.3)	
No	39 (47.6)	27 (71.1)	
COVID-19 Vaccine type, *n (%)*			
CORONAVAC	36 (83.7)	2 (18.2)	<0.001[Q]
PFIZER	1 (2.3)	1 (9.1)	
ASTRAZENECA/OXFORD	6 (14)	5 (45.5)	
Unknown	0 (0)	3 (27.3)	

Note: %, relative frequency; COI, cutoff index; F, Fisher's exact test; M, Mann-Whitney test; n, absolute frequency; Q, Pearson's chi-squared test; SD, standard deviation.
*Tests could not be performed due to lack of variability.
[a]Significant when *P*-value <0.05.

inmates ($P < 0.001$). Residents had greater exposure to the virus, according to the presence of the IgM antibody, with a higher positive mean compared with the staff group ($P < 0.001$). Regarding IgG, there was no significant difference between 2 groups, relating to similar exposure to them. Due to the order of priority established by the Ministry of Health, residents have a higher average first dose than guards ($P < 0.002$) and the most applied vaccine was coronavac.

Regarding the analysis of neutralizing antibodies, we can infer that the vaccinated inmates have an average Ab of 67.19 in relation to the average of 43.21 ($P < 0.001$) in inmates who had not yet been vaccinated. Of interest, although they have not yet been vaccinated, exposure to the infection generated neutralizing antibodies above the reference (>30) in 51.3% of unvaccinated inmates, knowing that the duration of these antibodies is shorter than those induced by the vaccination.

Furthermore, the vaccinated staff had an average of 65.16 of AcN compared with those who had not been vaccinated yet (31.76) with a significant difference between the groups ($P = 0.001$). It is worth mentioning that, of the nonvaccinated staff, the majority (63%) had negative AcN, showing that, despite having an average of neutralizers above the reference, most do not have protection against SARS-CoV-2 by the analyzed test ($P = 0.004$).

Data from vaccinated adolescents show a higher amount of neutralizing antibodies than the staff (67.19 to 65.16) and among unvaccinated inmates, the average of AcN is greater than 30% (43.21 to 31.76), suggesting that, due to age and confined environments, there is a greater formation of neutralizing antibodies in this population.[9]

However, the neutralizing antibody level depended on several factors, including age and comorbidities (eg, a 48-y-old employee with systemic arterial hypertension exhibited only 14.6% of neutralizing antibodies after the first dose).

Regarding the occurrence of previous clinical manifestations of COVID-19, testing for COVID-19, and recognized exposure to COVID- 19, no significant difference was observed between vaccinated and unvaccinated individuals, both in the resident and employee groups, as shown in Table 2. Like previous studies

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Table 2. COVID-19 clinical manifestations, exposure, serology, and neutralizing antibodies between residents and employees according to vaccination status

	Resident			Staff		
COVID-19 clinical manifestations during past 2 weeks	Vaccinated	unvaccinated	P value	Vaccinated	Unvaccinated	*P*-Value[a]
Headache, *n (%)*	1 (2.3)	2 (5.1)	0.602[F]	2 (18.2)	3 (11.1)	0.615[F]
Runny nose, n (%)	0 (0)	1 (2.6)	0.476[F]	0 (0)	1 (3.7)	1,.000[F]
Sore throat, *n (%)*	0 (0)	2 (5.1)	0.223[F]	0 (0)	3 (11.1)	0.542[F]
Cough, *n (%)*	0 (0)	1 (2.6)	0.476[F]	0 (0)	7 (25.9)	0.084[F]
Fever, *n (%)*	2 (4.7)	1 (2.6)	1.000[F]	1 (9.1)	8 (29.6)	0.237[F]
Headache, n (%)	2 (4.7)	1 (2.6)	1.000[F]	5 (45.5)	10 (37)	0.722[F]
Difficulty breathing, *n (%)*	1 (2.3)	0 (0)	1.000[F]	2 (18.2)	1 (3.7)	0.196[F]
Ageusia, *n (%)*	4 (9.3)	0 (0)	0.118[F]	2 (18.2)	5 (18.5)	1.000[F]
Anosmia, *n (%)*	2 (4.7)	0 (0)	0.495[F]	2 (18.2)	5 (18.5)	1.000[F]
Pain, *n (%)*	1 (2.3)	0 (0)	1.000[F]	2 (18.2)	6 (22.2)	1.000[F]
Recognized exposure to COVID-19, n (%)	8 (18.6)	5 (12.8)	0.554[F]	7 (63.6)	9 (33.3)	0.147[F]
IgM antibodies (COI), *Mean (SD)*	1.96 (1.88)	1,48 (1.51)	0.163[M]	0,9 (1.8)	0,69 (1.27)	0.680[M]
IgG antibodies (COI), *Mean (SD)*	8.42 (8.14)	6,36 (7.54)	0.272[M]	11,02 (10.92)	7,34 (8.4)	0.356[M]
Neutralizing antibodies, *Mean (SD)*	67.19 (17.18)	43,21 (27.47)	<0.001[M]	65,16 (27.58)	31,76 (21.03)	0.001[M]
Positive, *n (%)*	43 (100)	20 (51.3)	<0.001[F]	10 (90.9)	10 (37)	0.004[F]
Negative	0 (0)	19 (48.7)		1 (9.1)	17 (63)	

Note: %, relative frequency; F, Fisher's exact test; M, Mann-Whitney test; n, absolute frequency; Q, Pearson's chi-squared test; SD, standard deviation.
[a]Significant when *P*-value <0.05.

conducted in prisons, the most prevalent COVID-19 clinical manifestations were fever, headache, and cough.[3]

In short, the neutralizing antibodies response is more expressive among the vaccinated group, being predictive of immune protection from COVID-19.[9] Additionally, the vaccination process has contributed for significant reduction of associated symptoms to long covid as observed by some authors.[10] Although other studies have shown that a single mRNA vaccine dose was not sufficient to generate an adequate immunological response among individuals not previously infected with SARS-CoV-2,[11] data from the first dose of the Pfizer vaccine showed 45.9% neutralizing antibodies for 1 adolescent (committed by the HIV virus) and 77.3% for 1 employee (39 y old without health problems).

Unfortunately, these data do not allow us to make further conclusions due to the small sample size. Also, there are differences about age and vaccine type between resident and employee groups that could affect neutralizing antibodies levels. Nevertheless, the higher production of neutralizing antibodies among vaccinated residents shows why vaccination of this population is essential and must be prioritized in public vaccination policies in developing countries such as Brazil and developed countries.

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