Sero-prevalence of anti-SARS-CoV-2 antibodies among communities between July and August 2022 in Bangui, Central African Republic

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Abstract

Background. Large-scale population-based seroprevalence studies of SARS-CoV-2 are essential to characterize the cumulative incidence of SARS-CoV-2 infection and to extrapolate the prevalence of presumptive immunity at the population level. Objective. The objective of our survey was to estimate the cumulative population immunity for COVID-19 and to identify individual characteristics associated with positive serostatus.

Materials and Methods. This was a clustered cross-sectional study conducted from July 12 to August 20, 2021, in households in the city of Bangui, the capital of the Central African Republic. Information regarding demographic characteristics (age, gender, and place of residence), and comorbidities (chronic diseases) was collected. A venous blood sample was obtained from each participant to determine the level of total anti-SARS-CoV-2 antibodies using a WANTAI SARS-CoV-2 Ab ELISA kit.

Results. All up, 799 participants were surveyed. The average age was 27 years, and 45.8% of the respondents were male (sex ratio: 0.8). The overall proportion of respondents with positive serostatus was 74.1%. Participants over 20 years of age were twice as likely to have positive serostatus, with an OR of 2.2 [95% CI: (1.6, 3.1)].

Conclusions. The results of this survey revealed a high cumulative level of immunity in Bangui, thus indicating a significant degree of spread of SARS-CoV-2 in the population. The public health implications of this immunity to SARS-CoV-2 such as the post-vaccination total antibody kinetics remain to be determined.

Introduction

On January 30, 2020, the World Health Organization (WHO) declared the COVID-19 outbreak a public health emergency of international concern, and in March 2020, it began referring to it as a pandemic so as to underscore the seriousness of the situation and to urge all countries to take steps to detect the infection and prevent its spread.[1] The rapid spread of SARS-CoV-2 has led scientists around the world to conduct extensive research to better understand and tackle this insidious virus, described by the WHO as the "enemy of humanity". SARS-CoV-2 continues to have a profound impact on human society. Different countries and regions have adopted different policies to control and prevent the spread of SARS-CoV-2. It is known that the speed of spread of most viruses is highly dependent on the density of the host population.[2] SARS-CoV-2 is transmitted primarily directly from person to person, including through respiratory droplets produced when an infected individual has COVID-19 symptoms. These droplets emitted when

an infected individual sneezes or coughs can become lodged in the mouths or noses of people who are nearby, or they can eventually become deposited in the lungs after being inhaled. Transmission of SARS-CoV-2 from asymptomatic (or incubating) individuals has also been described.[3] Large-scale seroprevalence studies of the SARS-CoV-2 population are essential to characterize the cumulative incidence of SARS-CoV-2 infection and to extrapolate the prevalence of presumptive immunity at the population level. Detection of antibodies to the SARS-CoV-2 core protein (anti-N) reflects a history of natural infection, whereas detection of antibodies to the SARS-CoV-2 spike-1 protein (anti-S1) reflects either a history of natural infection or spike-based vaccination. Unlike data generated by biological and medical laboratory case-based surveillance systems that are sensitive to heterogeneities in test use and case reporting, large-scale population-based seroprevalence surveys have the potential to detect evidence of any past infections, including asymptomatic infections.[4] In the year 2020, a number of countries rapidly implemented population-based and targeted group seroprevalence studies of anti-SARS-CoV-2 antibodies. The literature on this topic reports a seroprevalence ranging from 0.08% to 31.5%.[5,6] In Africa, an analysis of 23 studies conducted between April 2020 and April 2021 found that the mean seroprevalence of anti-SARS-CoV-2 antibodies was 22% (95% CI: 14%-31%).[7] In the Central African Republic (CAR), the first case of COVID-19 was detected on March 14, 2020. Measures to control the spread of the epidemic were quickly adopted by the CAR health authorities. On June 30, 2021, the official situation report stated that 57,434 people had been tested for COVID-19, with 11,061 cumulative confirmed cases (7,141 symptomatic and 3,920 asymptomatic cases). Anti-COVID-19 vaccination has been implemented since May 20, 2021. As of June 3, 2021, 78,685 people in the CAR have been vaccinated against COVID-19.[8] The objective of this study was to measure the level of cumulative anti-SARS-CoV-2 immunity in the general population not vaccinated against this disease in Bangui, the capital of the Central African Republic.

Materials and Methods

Study design and setting

This was a cross-sectional study conducted from July 12 to August 20, 2021, in the general population of the city of Bangui. The Central African Republic is a landlocked country with a surface area of 622,984 km^2 located in Central Africa. According to the Central African Institute of Economic Statistics and Social Studies (ICASEES), the population was determined to be approximately 4,500,000 in 2020. The majority of this population is located in the capital city of Bangui (approximately 900,000 inhabitants). Bangui is a city composed of eight arrondissements or boroughs, with a total of 181 districts (considered as clusters in this study). The COVID-19 epidemic in the CAR is currently composed of two waves (weeks 20 to 33 in 2020 and weeks 10 to 22 in 2021).

Sampling

The sample size required for an expected prevalence of 50%, with a margin of error of 5% and a cluster effect of 2, was estimated to amount to 768 individuals. We performed a random cluster sampling according to the method described by Bennett *et al*.[9] Briefly, we selected 25 districts, using the probability proportional sampling method based on the population size of each district. At the district level, eleven households were also randomly selected, and at least three members in each household were then included in the survey.

Data collection of biological samples

Individual information about each participant's age, gender, place of residence, level of education, and comorbidities was collected using a structured questionnaire. For each participant, a 2-milliliter blood sample was collected in a dry tube. These samples were stored in a cooler at 4°C and sent the same day (within 6 hours of collection) to the Pasteur Institute in Bangui for serological analysis. Informed and signed consent was obtained from each participant.

Serological testing

The serum samples were screened for SARS-CoV-2 antibodies using a SARS-CoV-2 total antibody ELISA kit (Wantai Biological Pharmacy Enterprise Co., Ltd., Beijing, China) according to the manufacturer's instructions.[10] The performance of this Wantai ELISA test has been previously evaluated using 180 plasma bank samples from before May 2019, resulting in a specificity of 99.4%.

Briefly, the Wantai ELISA kit used is based on a double-antigen sandwich assay: the solid phase is coated with recombinant SARS-CoV-2 antigens, which can simultaneously bind antibody isotypes (IgA, IgM, and IgG) directed against SARS-CoV-2. For detection, a labelled SARS-CoV-2 antigen is used.

Data collection and analysis

The data were entered into an Access 2016 database, and the statistical analyses were performed with STATA version 14 software (StataCorp, College Station, TX, USA). We explored the distribution of IgA, IgM, and IgG total levels according to the characteristics of the study population. The effect of each of these characteristics on SARS-Cov-2 seropositivity was analyzed and presented as odds ratios with a 95% confidence interval. A cut-off equal to 0.05 was used to determine statistical significance.

Ethical clearance

This study was authorized by the Ministry of Health of the Central African Republic (N° 603/MSPP/DIRCAB/CMRF-21) and by the Ethics and Scientific Committee of the University of Bangui (N°09/UB/FACSS/IPB/CES/20).

Table 1. Characteristics of the study population.

Characteristics		Number	%
Age	≤20	307	38.4
	21-40	358	44.8
	41-60	116	14.5
	≥60	18	2.3
Gender	Male	366	45.8
	Female	433	54.2
Education	None	144	13.0
	Primary	229	30.4
	College	333	44.2
	High school/Lycee	93	12.4
Chronic diseases	Diabetes	2	0.3
	Hypertension	4	0.5
	Other cardiovascular diseases	5	0.6
	Other pathologies	49	6.1
Borough of Bangui	Borough 1	123	15.4
	Borough 2	51	6.4
	Borough 3	58	7.3
	Borough 4	29	3.6
	Borough 5	154	19.3
	Borough 6	94	11.8
	Borough 7	151	18.9
	Borough 8	139	17.4

Results

Characteristics of the participants

A total of 799 participants were included in this study. Their mean age was 27 years (from 1 year to 75 years). Male participants accounted for 45.8% of the sample (sex ratio: 0.8). Sixty participants (7.5%) reported having a chronic disease, such as diabetes (n=2) and cardiovascular disease (n=9). The characteristics of the participants are detailed in Table 1.

Serological test results

For 74.1% of the sample (592/799), the serological test was positive for SARS-CoV-2. Table 2 shows the distribution of the serological results according to the characteristics of the study population. The seroprevalence was 66.1% (203/307), 81.8% (293/358), 79.3% (92/116), and 83.3% (15/18) for the ≤20 years, 21 to 40 years, 41 to 60 years, and ≥61 years of age brackets, respectively. The risk of having a positive serological status was twice as high in the participants aged more than 20 years than in those who were younger, with an OR of 2.2 [95% CI: (1.6, 3.1)]. The proportions of the serological results were similar for both genders. However, there was an effect of the level of education of the participants on the serological status. The higher their level of education, the more positive their SARS-CoV-2 serological status was. Participants with a high school education were four times more likely to be SARS-CoV-2 positive than those with less education, with an OR of 4.3 [95% CI: (2.5, 7.3)] and 3.58 [95% CI: (1.8, 7.0)] for those with a high school/Lycee or university education, respectively. Of the 60 participants who exhibited comorbidities, 78.3% (n=60) had a positive serology versus 72.6% (537/739) for the participants without comorbidities (such as diabetes and cardiovascular diseases). However, the difference between these proportions was not statistically significant (p=0.36).

The distribution of the participants with a positive serological status varied according to the boroughs of Bangui (Figure 1).

The seroprevalence varied between 57% and 89% for the various boroughs that were studied.

Discussion

This is the first serological survey conducted in the general urban population of the CAR more than one year after the COVID-19 pandemic started in the country (March 2020). The prevalence of anti-SARS-CoV-2 antibodies was 74.1% in the population not already vaccinated against COVID-19. To our knowledge, this is a very high seroprevalence compared to those reported to date in Africa. This result, therefore, indicates a very high degree of contact with the study population with SARS-CoV-2 in Bangui. The main reason for this high seroprevalence is presumably the lack of application of preventive measures by the general population, irrespective of their nature, in particular strict confinement, social distancing, and the wearing of masks. These measures have essentially never been adhered to due to economic and sociological reasons.

In the various countries surrounding the CAR, such as the Democratic Republic of Congo, the Republic of Congo, Cameroon, and South Sudan, the prevalence of anti-SARS-CoV-2 antibodies has been reported to be 16.6%, 17.6%, 29.2%, 32%, and 38.5%, respectively.[11-14] However, these studies were conducted earlier on in the pandemic than our survey at a time when the CAR had just experienced two COVID-19 waves in May-July 2020 and March-April 2021.[8] Varying seroprevalences have also been reported in other African countries.[15-19] The difference observed with these results may be explained by the specific populations in which some of these studies were carried out, as well as by the type of laboratory test used. In our study, we probably did not miss recent infections because we tested for the presence of total antibodies (WANTAI SARS-CoV-2 Ab ELISA).

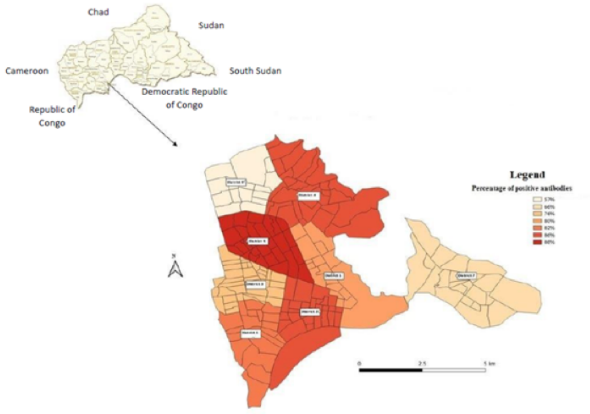

Figure 1. COVID-19 seroprevalence mapping in Bangui, Central African Republic, July-August 2021.

Table 2. Distribution of the serological results according to the characteristics of the study population.

Characteristics		N	SARS-CoV-2 positive serology		OR	95% CI	p-value
			n	%			
Age	≤20	307	203	66.1	Ref.		
	21-40	358	293	81.8	2.3	[1.61, 3.3]	0.001
	41-60	116	92	79.3	1.9	[1.18, 3.3]	0.001
	≥60	18	15	83.3	2.6	[0.72, 9.0]	0.14
Gender	Male	366	278	76.0	0.9	[0.7, 1.3]	0.76
	Female	433	325	75.1			
Education	None	144	91	63.2	Ref.		
	Primary	229	147	64.2	1.0	[0.7, 1.6]	0.84
	College	114	92	80.7	2.4	[1.4, 4.3]	0.002
	High school/Lycee	219	193	88.1	4.3	[2.5, 7.3]	0.001
	University	93	80	86.0	3.6	[1.8, 7.0]	0.001
Chronic disease	No	739	537	72.9	Ref.	[0.7, 2.5]	0.36
	Yes	60	47	78.3	1.3		

Although we observed a trend among the various age groups, the seroprevalence was significantly associated with age groups. This finding corroborates the results of several studies that indicate that anti-SARS-CoV-2 antibody responses require age-specific approaches. For example, in Iran, a study reported a trend of anti-SARS-CoV-2 antibody prevalence according to age.[20] In Switzerland, Stringhini *et al.*, in their population study carried out between April 6 and May 9, 2020, found that the seroprevalence was significantly lower among young children (5-9 years) and older people (≥65 years) than for the other age groups.[21]

The third major finding of our study is the effect of the high level of education on the SARS-CoV-2 serological status. This indicates that the educational level of the population has little impact on compliance with the recommended preventative measures for COVID-19 in the country.

Conclusions

The present study shows a very high level of seroprevalence of anti-SARS-CoV-2 antibodies in communities in Bangui. This result suggests a very high degree of exposure in the general population to SARS-CoV-2. However, the public health implications of this immunity remain to be determined such as the post-vaccination total antibody kinetics in previous SARS-CoV-2 infected populations. Indeed, Dimeglio *et al*. reported that the post-vaccination total antibody titer decreases faster in vaccinated people with no previous SARS-CoV-2 infection than in vaccinated/infected individuals.[22] Hence, our study calls for more comprehensive studies on the synergistic effect of vaccination and pre-vaccination infectious status on the duration of the protection in the CAR.

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