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## Trend of expansion of SARS-CoV-2 infection and COVID-19 burden in Gabon (Central Africa) in mid-2021, based on a serological survey

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### A B S T R A C T

**Objective:** To estimate the seroprevalence of anti-SARS-CoV-2 antibodies in the general population in Gabon, Central Africa.

**Methods:** From May to July 2021, a cross-sectional study involving participants recruited in the general population in three districts in Gabon was conducted. Eligible participants who provided written informed consent were tested for anti-SARS-CoV-2 antibodies using a simple rapid diagnostic assay.

**Results:** Overall, 1609 participants were recruited, 1361 (84.6%) from urban sites and 248 (15.4%) from a rural area. The estimated overall seroprevalence was 13.1% (95% CI 11.4–14.8%). The risk of seropositivity increased with age, and the prevalence in the different age groups ranged from 12.9% (8.0–19.4%) in those aged 15–24 years to 23.3% (14.2–34.6%) in those ≥ 65 years old. A higher prevalence was found in the rural population (17.3%; 12.8–22.6%) compared with urban regions (12.3%; 10.6–14.1%). Being a woman was also associated with higher risk of infection ( $p < 0.001$ ).

**Conclusions:** This seroprevalence survey revealed a moderate seroprevalence in Gabon, illustrating a relatively low rate of circulation of the virus in the country and correlating with low numbers of confirmed cases and deaths reported to date.

### Introduction

Two years after the emergence of coronavirus disease 2019 (COVID-19), associated with SARS-CoV-2 infection, up to 425 million cases had been confirmed worldwide, of which less than 2% (representing about 8 million cases) had been reported in Africa (WHO, 2022). Contrary to initial legitimate predictions and fears for a rapid expansion of the virus and COVID-19 in Africa and in other resource-limited settings, given the difficulties in implementing population-level preventive measures and efficient routine diagnosis and medical interventions, alongside other operational challenges related to these contexts (Peeling et al., 2020; Truelove et al., 2020), the overall situation for this continent has remained stable and mostly characterized by lower rates of confirmed cases and deaths when compared with other regions, such as Europe and the USA (WHO, 2022).

Several hypotheses have been advanced to explain this situation, including: poor routine surveillance; suboptimal testing resulting in underreporting of infected individuals; and African demography, with its younger population (Diop et al., 2020; Njenga et al., 2020). However, the real and future impact of COVID-19 in Africa should not be underestimated, as the majority of data generated on the pandemic are

from other settings, and knowledge on the exact progression and impact of the disease on this continent remains limited (Gignoux et al., 2021; Peeling et al., 2020).

Difficulties in implementing effective and sufficient molecular testing programs, including the global shortage of reagents and supplies for testing faced in the first year of the pandemic and in early 2021 (Peeling et al., 2020), have led to a call for alternative approaches. These include WHO recommendations for population-based studies to determine the proportion of the population that has been infected over time, in order to inform public-health policy (WHO, 2020).

In Gabon, as in many African countries, the first confirmed COVID-19 cases were reported in early 2020, with a total of 47 506 cases reported in February 2022 (WHO, 2022). If all these cases are considered as primary infections, this number represents less than 3% of the Gabon population and largely represents symptomatic cases that were tested. However, it provides little or no information on the rate of disease spread in the country, as demonstrated in other settings (Angulo et al., 2021; Ngere et al., 2021).

In a previous cross-sectional study conducted in Libreville, Gabon the mortality rate associated with COVID-19 infection from March to June 2020 was shown to be low, and patients who died of COVID-19

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infection were found to be younger on average than reported elsewhere (Iroungou et al., 2021). The present study aimed to estimate the seroprevalence of SARS-CoV-2 infection in three districts of Gabon in May 2021, including urban and rural settings, in order to better understand the trend of SARS-CoV-2 spread in the country.

## Materials and methods

### Design and settings

A cross-sectional survey was implemented from May to July 2021 to estimate SARS-CoV-2 seroprevalence in Gabon. For this cross-sectional survey, the necessary sample size was estimated by assuming a reference seroprevalence of 10% for this period, and an estimated error scale of 1% for a 95% confidence interval. The 10% seroprevalence used to generate this sampling assumption was arbitrarily chosen because no data were available for most African countries at that time. Study participants were recruited in three regions of the country — two urban regions, including the capital city Libreville and Port-Gentil, and one rural region, Oyem, on the eastern side of the country. Based on the 2013 census (DGS, 2015), the overall national population was 1 811 079, while the total population of the analyzed areas was 800 532, thus representing 44.2% of the national population.

The study participants were recruited from the general population, with the inclusion criteria being aged  $\geq 15$  years and able to provide a written informed consent. Being vaccinated for COVID-19 was an exclusion criterion. Less than 5% of the national population had been vaccinated at the time of study initiation (WHO, 2022), and thus excluding this part of the population was not expected to represent a major bias. A study questionnaire was implemented to collect the following: sociodemographic data (e.g. age, gender, living conditions, and recent travels from or to the country); information on knowledge about SARS-CoV-2 infection, COVID-19, and associated preventive measures; and clinical status with regard to COVID-19. An on-field clinical assessment was conducted to identify potential signs of SARS-CoV-2 infection, including temperature measurements.

### Procedures and laboratory strategy

All eligible participants were tested for antibodies against SARS-CoV-2. A field-friendly lateral-flow immunoassay was used, which detected both immunoglobulin M (IgM) and immunoglobulin G (IgG), and provided results within a few minutes. The selected assay (Biosynex COVID-19 BSS IgG/IgM; Biosynex, Illkirch-Graffenstaden, France) was included in the French list of recommended assays for SARS-CoV-2 antibody detection (<https://covid-19.sante.gouv.fr/tests>) and was reported as offering good sensitivity ( $> 95\%$ ) and specificity ( $> 98\%$ ) (Pere et al., 2021). The assay can be performed using fingerstick blood samples, and provides results within 10 minutes; testing was performed according to manufacturer's recommendations. All participants with a body temperature  $> 38.5^\circ\text{C}$  and/or presenting IgM-positive results underwent nasopharyngeal swab collection. Swabs were used for COVID-19 testing, using a rapid antigen (Ag) test (Panbio COVID-19 Ag test; Abbott, Lake Country, IL, USA), which was performed according to manufacturer's instructions.

### Data analysis

Data analysis was conducted using R software (R-Core-Team, 2020). The 95% confidence intervals (CIs) associated with the values of seroprevalence for the various subsamples were exact binomial CIs. The association between seroprevalence and different covariates — age, gender, and living environment (urban vs rural) — was assessed using binomial generalized linear models, while likelihood ratio tests provided the corresponding  $p$ -values.

## Ethics

The study protocol was approved by the Gabon National Ethics Committee for Research, under the authorization 0039/2021/PR/SG/CNER. Only persons from whom written informed consent had been obtained were included in the study, and adequate measures were implemented throughout the investigation to safeguard participant confidentiality, including the use of anonymous identifiers.

## Results

### Population characteristics and knowledge of COVID-19

In total, 1609 participants were recruited to the study, of whom 1361 (84.6%) lived in urban regions and 248 (15.4%) in a rural area. Females represented 38.8% ( $n = 589$ ) of the participants — 37.8% ( $n = 483$ ) of those from the urban regions and 44.4% ( $n = 106$ ) of the rural inhabitants. The median age was 38 years (IQR 31–47), with almost no difference between the urban and rural regions (38 years and 36.5 years, respectively). The study participants were aged  $\geq 15$  years, with 9% ( $n = 147$ ) in the 15–24 years group, 77.3% ( $n = 1222$ ) in the 25–54 years group, 8.7% ( $n = 138$ ) in the 55–64 years group, and 4.6% aged 65 years and above. The majority of the study population was educated, with only 7.3% ( $n = 113$ ) reporting no educational level. Some 252 participants (16.8%) reported traveling outside the country since the beginning of the pandemic in January 2020 — 14.6% within the continent and 2.2% out of Africa. The most reported country visited was the neighboring Cameroon (56% of travels within the continent), with France accounting for most travels outside Africa (Table 1).

With regard to clinical signs relating to COVID-19, 12 participants (0.8%) presented with fever (body temperature  $\geq 38.5^\circ\text{C}$ ); 5.2% had cough; 6.8% declared headache; 2.9% reported difficulty with breathing, 2.6% presented with sore throat, and 1.5% reported signs of ageusia or anosmia. The majority of the study participants (98.9%) had been alerted to the ongoing pandemic through official news, relatives and friends, or social media. Up to 93% knew that COVID-19 was caused by a virus called SARS-CoV-2, and more than 95% reported wearing a mask (Table 1).

### SARS-CoV-2 seroprevalence and associated factors

The overall proportion of participants with a positive antibody test — IgM or IgG — was 13.1% (95% CI 11.4–14.8%). Only 1.5% (0.9–2.2%) tested positive for IgM, with or without IgG, indicative of an ongoing or recent infection; 12.3% (10.7–14.0%) were positive for IgG only, indicative of a past infection; and 0.75% (0.4–1.3%) had evidence of both IgM and IgG (Table 2A).

The proportion of participants positive for IgM or IgG was higher in the rural area, at 17.3% (12.8–22.6%), compared with the urban regions, at 12.3% (10.6–14.1%), with this difference being statistically significant ( $p = 0.042$ ). In the global analysis, the proportion of participants testing positive was similar for the 15–24 years and 25–54 years age groups, at 12.9% (8.0–19.4%) and 12.2% (10.5–14.3%), respectively, although the CI was tighter in the second group. This proportion increased to 16.1% (10.3–23.3%) in 55–64 years age group, and reached 23.5% (14.2–34.6%) in those aged  $\geq 65$  years. A similar trend was observed in the urban population (Table 2B), with the proportion of those testing positive increasing gradually with age: 8.0%, 11.6%, 16.8%, and 25.0% for those aged 15–24 years, 25–54 years, 55–64 years, and  $\geq 65$  years, respectively. However, for the rural region, the highest prevalence was found in the 15–24 years age group, at 20.3% (11.0–32.8%), and the lowest prevalence was found in participants aged 25–54 years, at 12.5% (2.7–32.4%).

According to the multivariate analysis, the risk of being seropositive increased significantly with age (OR = 1.019, 95% CI 1.008–1.031;  $p = 0.00098$ ), while being male was associated with reduced risk

**Table 1**  
Participants' characteristics.

Characteristics	Urban region (%)	Rural region (%)	Missing data (%)	Overall (%)
Total recruited	1361 (84.6%)	248 (15.4%)		1609
Female	483 (37.8%)	106 (44.4%)	93 (5.8%)	589 (38.8%)
Median age, years (IQR)	38 (31–47)	36.5 (25–48)	29 (1.8%)	38 (31–47)
Educational level			121 (7.5%)	
None	97 (7.8%)	16 (6.6%)		113 (7.6%)
Primary school	170 (13.7%)	26 (10.7%)		196 (13.2%)
Secondary school	588 (47.2%)	150 (61.7%)		738 (49.6%)
University	390 (31.3%)	51 (21.0%)		441 (29.6%)
Marital status				
Married	471 (36.1%)	81 (33.6%)	63 (3.9%)	552 (35.7%)
Travels abroad since Jan 2020			110 (6.8%)	
Inside Africa	108 (8.6%)	111 (45.7%)		219 (14.6%)
Outside Africa	32 (2.5%)	1 (0.4%)		33 (2.2%)
Suspicious clinical signs				
Fever (T <sup>o</sup> > 38.5°C)	12 (0.9%)	0	19 (1.2%)	12 (0.8%)
Cough	72 (5.3%)	10 (4.1%)	18 (1.1%)	82 (5.2%)
Headache	96 (7.1%)	13 (5.3%)	13 (0.8%)	109 (6.8%)
Breathing distress	38 (2.8%)	8 (3.3%)	14 (0.9%)	46 (2.9%)
Sore throat	37 (2.7%)	4 (1.6%)	17 (1.1%)	41 (2.6%)
Ageusia or anosmia	22 (1.6%)	2 (0.8%)	15 (0.9%)	24 (1.5%)
Knowledge of COVID-19				
Heard about COVID-19	1306 (98.6%)	245 (100%)	40 (2.5%)	1551 (98.9%)
Knew SARS-CoV-2 is a virus	1263 (97.1%)	174 (71.6%)	65 (4.0%)	1437 (93.1%)
Reported wearing mask	1281 (98.8%)	194 (80.2%)	71 (4.4%)	1475 (95.9%)

IQR: interquartile range

**Table 2**  
SARS-CoV-2 seroprevalence.

A. Overall seroprevalence			
Parameters	Urban region	Rural region	Overall
Tested for SARS-CoV-2 antibodies	1352	248	1600
Positive for IgM (95% CI)	1.63% (1.0–2.5)	0.8% (0.09–2.9)	1.5% (0.9–2.2)
Positive for IgM + IgG	0.8% (0.4–1.5)	0.4% (0.01–2.2)	0.75% (0.4–1.3)
Positive for IgG	11.5% (9.8–13.3)	16.9% (12.5–22.2)	12.3% (10.7–14.0)
Positive for IgM or IgG	12.3% (10.6–14.1)	17.3% (12.8–22.6)	13.1% (11.4–14.8)
Tested for SARS-CoV-2 antigens (Ag)	29; 2.1%	1; 0.4%	30; 1.9%
Ag positive	1; 3.4%	0	1; 3.3%
B. Seroprevalence per age group			
Parameters	Urban region	Rural region	Overall
15–24 years	88	59	147
Positive for IgM (95% CI)	0% (0–4.1)	0% (0–6.1)	0% (0–2.5)
Positive for IgM + IgG	0% (0–4.1)	0% (0–6.1)	0% (0–2.5)
Positive for IgG	8.0% (3.3–15.7)	20.3% (11.0–32.8)	12.9% (8.0–19.4)
Positive IgM or IgG	8.0% (3.3–15.7)	20.3% (11.0–32.8)	12.9% (8.0–19.4)
25–54 years	1074	148	1222
Positive for IgM	1.6% (0.9–2.5)	0.7% (0.02–3.7)	1.5% (0.9–2.3)
Positive for IgM + IgG	0.8% (0.4–1.6)	0% (0–2.5)	0.7% (0.3–1.4)
Positive for IgG	10.8% (9.0–12.8)	16.2% (10.7–23.2)	11.5% (9.7–13.4)
Positive IgM or IgG	11.6% (9.8–13.7)	16.9% (11.2–23.9)	12.2% (10.5–14.3)
55–64 years	114	24	138
Positive for IgM	1.8% (0.2–6.2)	4.2% (0.1–21.1)	2.2% (0.5–6.2)
Positive for IgM + IgG	0. % (0.2–4.8)	4.2% (0.1–21.1)	1.4% (0.1–5.1)
Positive for IgG	15.8% (9.6–23.8)	12.5% (2.7–32.3)	15.2% (9.7–22.3)
Positive IgM or IgG	16.8% (10.4–25.0)	12.5% (2.7–32.4)	16.1% (10.3–23.3)
≥ 65 years	60	13	73
Positive for IgM	5.0% (1.0–13.9)	0% (0–24.7)	4.1% (0.9–11.5)
Positive for IgM + IgG	1.7% (0.04–8.9)	0% (0–24.7)	1.4% (0.03–7.4)
Positive for IgG	21.7% (12.1–34.2)	15.4% (1.9–45.4)	20.5% (12.0–31.6)
Positive IgM or IgG	25.0% (14.7–37.9)	15.4% (1.9–45.4)	23.3% (14.2–34.6)

IgM: immunoglobulin M; IgG: immunoglobulin G

(OR = 0.50, 95% CI 0.37–0.69;  $p = 0.000012$ , as was living in the urban regions (OR = 0.67, 95% CI 0.45–0.99;  $p = 0.042$ ).

## Discussion

One of the major characteristics of the COVID-19 pandemic, since its start in early 2020, has been the unequal distribution of confirmed

cases and related deaths in different regions of the world. Indeed, from the almost 425 million cases confirmed to date, less than 2% were reported in Africa, representing around 8 million cases, of which 4 million (50%) were from South Africa (WHO, 2022). At the time this study was initiated, in March 2021, around 3 million cases had been reported in Africa, including just 15 500 cases in Gabon (WHO, 2022). The reasons for this 'African exception' remain unclear, but investigating population

exposure to the infection using serosurveillance of SARS-CoV-2 antibodies can provide some information and thus a possible explanation.

In this cross-sectional survey conducted in three regions in Gabon — two urban and one rural — a SARS-CoV-2 antibody seroprevalence of 13.1% (95% CI 11.4–14.8%) was ascertained in participants recruited from the general population between May and July 2021, a year and a half after the first reported cases in the country. In a previous study conducted in a mother-and-child university hospital in Libreville, Gabon, the authors reported a SARS-CoV-2 seroprevalence of 36.2% in patients attending the hospital between July and October 2020 (Mveang Nzoghe et al., 2021). The higher prevalence observed in this previous study may be explained the included patients attending hospital, and thus at risk of ongoing or previous COVID-19 infection, thereby representing a selection bias. Moreover, the study included participants aged 0–78 years — predominantly newborns, children, and women (only 7% (105/1492) were men) — and thus cannot be compared to the present study.

Compared with other similar studies conducted in the African region, our results indicated a moderate level of seroprevalence. An earlier cross-sectional study conducted in six districts in Zambia reported an overall SARS-CoV-2 seroprevalence of 10.6%, ranging from 6.0% to 14.4% depending on the district (Mulenga et al., 2021). Another population-based, cross-sectional survey conducted in Nairobi, Kenya, in November 2020, reported a seroprevalence of 34.7% (Ngere et al., 2021) — higher than the 22.7% found in the same country in a population of 9000 blood donors (Adetifa et al., 2021). In a study conducted from May 2020 to March 2021, in a population of 1206 participants in a refugee camp in Kenya, an overall 5.8% seroprevalence was reported — much lower than findings from other surveys conducted in the country (Gignoux et al., 2021).

Studies conducted in other countries and regions outside of Africa also showed variable results, depending on the population assessed and the implementation period. A large cross-sectional survey conducted in 18 cities in Iran at the end of 2020, and including 9181 individuals, found an overall seroprevalence of 17.1%, ranging from 1.7% to 72.6% (Poustchi et al., 2021). Finally, a large study conducted in the USA from April to May 2020, and involving five states (California, Florida, Georgia, Indiana, and New York), reported an overall estimated SARS-CoV-2 seroprevalence of 14.3% (IQR 11.6–18.5%) (Angulo et al., 2021) — close to our findings in Gabon a year later.

In a systematic review and meta-analysis gathering SARS-CoV-2 seroprevalence data generated in several African countries before April 2021, and including 23 studies and up to 27 735 individuals, the overall SARS-CoV-2 antibody prevalence was 22% (95% CI 14–31%), ranging from 0% to 63% depending on the location (Chisale et al., 2022). The seroprevalence reported in our study was close to those reported from many settings included in this meta-analysis, but a major limitation of the Chisale et al. study was the high heterogeneity of study designs included and of the types of population considered. However, it provided a general overview of SARS-CoV-2 prevalence on the African continent, where data relating to this pandemic remain scarce.

Altogether, our results indicated a lower progression of the virus in Gabon compared with other countries and regions, with our findings correlating with the relatively low number of confirmed cases reported in the country to date (WHO, 2022). The reasons for this lower rate of circulation of the virus in the country at the beginning of the pandemic, coupled with public health actions that were implemented by the national authorities. Indeed, travel limitations — within and outside of the country — were implemented very early in February 2020, with a 9-month nationwide lockdown applied from March to September 2020, all potentially contributing to a limited circulation of the virus in the country.

As observed in other studies, a significantly higher risk of infection was found in older populations ( $p = 0.00098$ ), with the highest risk found in participants aged  $\geq 65$  years (Gignoux et al., 2021; Pagani et al., 2020; Poustchi et al., 2021). This finding stresses the need for robust

public-health actions to support this population group, which is more at risk of developing severe COVID-19 forms and subsequent death (Huang et al., 2020). These actions should include improved access to diagnosis in case of suspicious symptoms, availability of emergency care services, and vaccination.

Contrary to the scant reports presenting SARS-CoV-2 seroprevalence data for African rural regions (Mulenga et al., 2021), our study found higher rates in the rural area compared with the urban sites ( $p = 0.042$ ). This is not a common finding and can be explained by the specificity of the rural area investigated. Indeed, the region is close to the Cameroon border, a country in which higher case rates of SARS-CoV-2 infection have been reported compared with Gabon, and it is likely that the high seroprevalence in this rural region is linked with community traveling between the two countries. Moreover, our data supported this hypothesis, because Cameroon was the top destination (56%) for those traveling outside the country. This may also explain the high prevalences observed in the rural 15–24 years and 25–54 years age groups, as these represent most of the workforce that travels abroad for business and/or family purposes.

Our study had some potential limitations. For example, it did not use population-based random sampling, and therefore the results cannot be truly extrapolated to the general population. Furthermore, we decided to use a simple rapid assay — the BIOSYNEX test — which may be less sensitive than ELISA assays. However, studies assessing this rapid assay have reported good performances, with high ( $> 95\%$ ) sensitivity and specificity (David et al., 2021; Pere et al., 2021). In addition, we believed that the advantages of using simple, point-of-care assays in African settings, where several operational challenges need to be considered, outweighed the benefits of ELISA-based strategies, which could potentially have delayed survey implementation, thus generating the need for more funding and resources, especially where rural settings were involved (Peeling et al., 2020). Finally, because antibodies decay over time, the seroprevalence results that we reported may have slightly underestimated the correct rate of exposure of the population to the virus.

## Conclusion

In this study, conducted more than 1 year after confirmation of the first SARS-CoV-2 cases in Gabon, a comparatively low/moderate level of seroprevalence was found, similar to levels reported for the USA in early 2020. This probably indicated a low circulation of the virus in Gabon, and correlated with the relatively low number of confirmed cases identified in the country. However, the results showed that all age groups are exposed to the virus, and the risk of infection can be also higher in rural settings, stressing the need for preventative measures, including vaccination, that involve all the population groups and country's regions.

## Author contributions

Conceptualization: BAI, PBM, FRN, and AFA. Funding acquisition: BAI, FRN, and AFA. Investigation and implementation: BAI, PBM, JM, EE, BBM, EW, JRN, FRN, and AFA. Data analysis: BAI, PBM, JM, EE, EW, FRN, and AFA. Writing: BAI, PBM, JM, EE, EW, FRN, and AFA.

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## Transparency declarations

None to declare.

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