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.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Prevalence of SARS-CoV-2 antibodies in the Republic of Congo in mid-2021

Fabien R. Niama\textsuperscript{a,b}, Félix Koukouikila-Koussounda\textsuperscript{a,b}, Pembé Issamou Mayengue\textsuperscript{a,b}, Eric Elguero\textsuperscript{c}, Tarcisse Baloki Ngoulou\textsuperscript{b}, Victor Levier\textsuperscript{e}, Jamal Makran\textsuperscript{e}, Berthe A. Iroungou\textsuperscript{c,d}, Avelin F. Aghokeng\textsuperscript{d,e,*}

\textsuperscript{a} National Laboratory of Public Health, Brazzaville, Republic of Congo
\textsuperscript{b} Marien NGouabi University, Brazzaville, Republic of Congo
\textsuperscript{c} Hôpital Universitaire de Bièvre, Paris, France.
\textsuperscript{d} Unité Mixte de Recherche Centre International de Recherches Médicales de Franceville et le Service de Santé Militaire, Libreville, Gabon
\textsuperscript{e} MIVEGEC, Université de Montpellier, CNRS, IRD, Montpellier, France

A R T I C L E   I N F O

Keywords:
SARS-CoV-2
Antibodies
COVID-19
Rural
Republic of Congo
Africa

A B S T R A C T

Objectives: To estimate the seroprevalence of severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) antibodies in the general population in the Republic of Congo.

Methods: In this cross-sectional study, conducted from June to July 2021, participants were recruited from the general population in three districts in the Republic of Congo. Eligible participants were tested for anti-SARS-CoV-2 antibodies using a rapid diagnostic assay.

Results: Overall, 31.8% [95% confidence interval (CI) 29.5–34.0] of the 1669 participants tested positive for anti-SARS-CoV-2 antibodies. Higher prevalence was observed in the rural region (37.3%, 95% CI 31.0–44.1%) than the urban region (30.9%, 95% CI 28.5–33.3); however, the difference was not significant. The risk of testing positive for anti-SARS-CoV-2 antibodies increased significantly with age, ranging from 22.5% (95% CI 18.1–27.5) in 15–24 year olds to 47.9% (95% CI 39.3–56.5) in 55–64 year olds.

Conclusions: The antibody levels observed in this survey correlate with a moderate rate of virus circulation, which correlates with the low number of confirmed cases of coronavirus disease 2019 in the Republic of Congo.

Introduction

The first cases of coronavirus disease 2019 (COVID-19) in the Republic of Congo were reported in early 2020, with possible introduction of the virus into the country in December 2019 (Bonguili et al., 2022). By July 2022, 24,421 confirmed cases and 386 deaths had been reported to the World Health Organization (WHO, 2022). The present study aimed to estimate the seroprevalence of severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) antibodies in three districts (urban and rural) of the Republic of Congo in June 2021, in order to better understand the trends of SARS-CoV-2 spread in the country.

Methods

A cross-sectional survey was implemented in June–July 2021 to estimate the seroprevalence of SARS-CoV-2 antibodies in the Republic of Congo. The sample size was estimated assuming reference seroprevalence of 10% and an estimated error scale of 1% with 95% confidence intervals (CI). Study participants were recruited from three regions: Brazzaville (capital of Republic of Congo), Pointe-Noire (economic capital) in the south; and Oussou (rural location) in the north. The study participants were recruited from the general population. The inclusion criteria were: age ≥15 years; and gave written informed consent. Subjects who had been vaccinated against COVID-19 were excluded from the study. Eligible participants were recruited consecutively until the required sample size was achieved. A questionnaire was implemented to collect sociodemographic data, including age; gender; living conditions; recent travel from/to the Republic of Congo; knowledge about SARS-CoV-2, COVID-19 and associated preventive measures; and COVID-19 status. A clinical assessment was conducted to identify potential signs of SARS-CoV-2 infection, including temperature records.

Participants were tested for antibodies against SARS-CoV-2 using a field-friendly lateral flow immunoassay, the Biosynex COVID-19 BSS IgG/IgM (BIOSYNEX, Illkirch-Graffenstaden, France). This assay has been reported to have good sensitivity (>95%) and specificity (>98%) (Pere et al., 2021). All participants with either body temperature >38.5°C or who tested positive for IgM underwent nasopharyngeal swab collection for SARS-CoV-2 antigen (Ag) testing using the Panbio COVID-19 Ag test (Abbott, Lake Country, IL, USA). Data analysis was...
**Table 1**

Participants' characteristics

| Characteristics           | Urban region (%) | Rural region (%) | Missing data (%) | Overall (%) |
|---------------------------|------------------|------------------|------------------|-------------|
| Total recruited           | 1444 (86.5%)     | 226 (13.5%)      | 1670             |             |
| Female                    | 566 (39.4%)      | 101 (44.7%)      | 7 (0.4%)         | 667 (40.1%) |
| Median age, years (IQR)   | 36 (26–46.25)    | 36 (30.25–44)    | 0 (0%)           | 56 (27.4%)  |
| Educational level         |                  |                  |                  |             |
| None                      | 51 (3.5%)        | 2 (0.9%)         | 53 (3.2%)        |             |
| Primary school            | 71 (4.9%)        | 16 (7.1%)        | 87 (5.2%)        |             |
| Secondary school          | 562 (38.9%)      | 134 (59.8%)      | 696 (41.7%)      |             |
| University                | 760 (52.6%)      | 72 (32.1%)       | 832 (49.9%)      |             |
| Marital status            |                  |                  |                  |             |
| Married                   | 603 (41.9%)      | 161 (71.9%)      | 7 (0.4%)         | 764 (45.9%) |
| Travel since Jan 2020     |                  | 5 (0.3%)         |                  |             |
| Inside Africa             | 82 (6.1%)        | 14 (6.2%)        | 96 (5.8%)        |             |
| Outside Africa            | 64 (4.8%)        | 5 (2.2%)         | 69 (4.1%)        |             |

**Table 2**

Seroprevalence of severe acute respiratory virus coronavirus-2 (SARS-CoV-2)

| Parameters                    | Urban region | Rural region | Overall |
|-------------------------------|--------------|--------------|---------|
| Tested for SARS-CoV-2 antibodies | 1444         | 225          | 1669    |
| Positive for IgM              | 4.4% (3.4–5.6) | 1.3% (0.3–3.8) | 4.0% (3.1–5.1) |
| Positive for IgM + IgG        | 2.8% (2.0–3.8) | 0.9% (0.1–3.2) | 2.6% (1.9–3.5) |
| Positive for IgG              | 29.3% (27.0–31.7) | 36.9% (30.6–43.6) | 30.3% (28.1–32.6) |
| Positive for IgG or IgM       | 30.9% (28.5–33.3) | 37.3% (31.0–44.1) | 31.8% (29.5–34.0) |
| Tested for SARS-CoV-2 antigen | 63 (4.4%)    | 3 (1.3%)     | 66 (4.0%) |
| Antigen positive              | 2 (3.2%)     | 1 (33.3%)   | 3 (4.5%) |

| Parameters                    | Urban region | Rural region | Overall |
|-------------------------------|--------------|--------------|---------|
| 15–24 years                   | 311          | 13           | 324     |
| Positive for IgM              | 3.9% (2.0–6.6) | 0.0% (0.0–24.7) | 3.7% (1.9–6.4) |
| Positive for IgM + IgG        | 2.9% (1.3–5.4) | 0.0% (0.0–24.7) | 2.8% (1.3–5.2) |
| Positive for IgG              | 22.2% (17.7–27.2) | 7.7% (0.2–36.0) | 21.6% (17.2–26.5) |
| Positive for IgG or IgM       | 23.1% (18.6–28.2) | 7.7% (0.2–36.0) | 22.5% (18.1–27.5) |
| 25–54 years                   | 957          | 200          | 1158    |
| Positive for IgM              | 4.3% (3.1–5.8) | 1.5% (0.3–4.3) | 3.8% (2.8–5.1) |
| Positive for IgM + IgG        | 2.5% (1.6–3.7) | 1.0% (0.1–3.6) | 2.3% (1.5–3.3) |
| Positive for IgG              | 29.0% (26.2–32.0) | 38.0% (31.2–45.1) | 30.6% (27.9–33.3) |
| Positive for IgG or IgM       | 30.8% (27.9–33.9) | 38.5% (31.7–45.6) | 32.1% (29.4–34.9) |
| 55–64 years                   | 128          | 12           | 140     |
| Positive for IgM              | 6.3% (2.7–11.9) | 0.0% (0.0–26.5) | 5.7% (2.5–10.9) |
| Positive for IgM + IgG        | 3.9% (1.3–8.9) | 0.0% (0.0–26.5) | 3.6% (1.2–8.1) |
| Positive for IgG              | 45.3% (36.5–54.3) | 50.0% (21.1–78.9) | 45.7% (37.3–54.3) |
| Positive for IgG or IgM       | 47.7% (38.8–56.7) | 50.0% (21.1–78.9) | 47.9% (39.3–56.5) |
| ≥65 years                     | 48           | 0            | 48      |
| Positive for IgM              | 6.3% (1.3–17.2) | 6.3% (1.3–17.2) | 6.3% (1.3–17.2) |
| Positive for IgM + IgG        | 6.3% (1.3–17.2) | 6.3% (1.3–17.2) | 6.3% (1.3–17.2) |
| Positive for IgG              | 37.5% (24.0–52.6) | 37.5% (24.0–52.6) | 37.5% (24.0–52.6) |
| Positive for IgG or IgM       | 37.5% (24.0–52.6) | 37.5% (24.0–52.6) | 37.5% (24.0–52.6) |

IgM, immunoglobulin M; IgG, immunoglobulin G; CI, confidence interval.

Numbers in parentheses are 95% confidence intervals.

Conducted using R software (R Core Team, 2020). The 95% CI associated with the seroprevalence values in diverse subsamples were exact binomial CI. Associations between seroprevalence and a number of covariates—age, gender and living environment (urban vs rural)—were assessed through binomial generalized linear models, and likelihood ratio tests provided the corresponding P-values.

**Results and discussion**

In total, 1670 participants were recruited into the study (e1). The overall proportion of patients testing positive for SARS-CoV-2 antibodies was 31.8% (95% CI 29.5–34.0%) (Table 2A). Only 4.0% (95% CI 3.1–5.1%) of patients tested positive for IgM, indicating a recent or on-
going infection, and 30.3% (95% CI 28.1–32.6%) of patients tested positive for IgM alone. The proportion of patients who tested positive for IgM and/or IgG was higher in the rural region (37.3%, 95% CI 31.0–44.1%) compared with the urban region (30.9%, 95% CI 28.5–33.3%), although the difference was not significant (P=0.062). The proportion of participants who tested positive for IgM and/or IgG increased with age, ranging from 22.5% (95% CI 18.1–27.5%) in patients aged 15–24 years to 47.9% (95% CI 39.3–56.5%) in patients aged 55–64 years. Similar trends were observed in both urban and rural populations (Table 2B). On multi-variante analysis, the risk of testing positive for IgM and/or IgG increased significantly with age (odds ratio 1.21, 95% CI 1.08–1.36; P=0.0001).

This cross-sectional survey found seroprevalence of SARS-CoV-2 antibodies at a similar level to that reported from other countries and regions. A cross-sectional study conducted in six districts in Zambia reported overall prevalence of 10.6%, ranging from 6.0% to 14.4% depending on the district (Mulenga et al., 2021). A survey conducted in Nairobi, Kenya in November 2020 reported seroprevalence of 34.7% (Ngere et al., 2021), which was higher than that found in a population of 9000 blood donors (22.7%) (Adetifa et al., 2021) and a population of refugees (5.8%) (Gignoux et al., 2021) in the same country. This illustrates the high heterogeneity of SARS-CoV-2 seroprevalence depending on region and survey period. Similar variations have been observed outside of Africa, depending on the population assessed and the implementation period. A large cross-sectional survey of 9181 individuals from 18 cities in Iran in late 2020 reported overall prevalence of 17.1%, ranging from 1.7% to 72.6% depending on the city (Pourstchi et al., 2021). A large study conducted in the USA from April to May 2020, involving five states (California, Florida, Georgia, Indiana, and New York), reported estimated SARS-CoV-2 seroprevalence of 14.3% (interquartile range 11.6–18.5%) overall (Angulo et al., 2021), which was lower than that found in this study in the Republic of Congo 1 year later.

As observed in other studies, the present study found a higher risk of infection in older populations, with the highest risk found in participants aged ≥55 years (Gignoux et al., 2021; Pourstchi et al., 2021). This finding stresses the need for robust public health action for this population group, which is at higher risk of developing severe COVID-19 and at higher risk of death (Huang et al., 2020). Contrary to other reports of SARS-CoV-2 seroprevalence from rural areas of Africa (Mulenga et al., 2021), the present study found higher prevalence in the rural region compared with the urban region; this correlates with the authors’ recent findings in a similar study conducted in Gabon (in press). This is not a common finding, and can be explained by local living conditions, less follow-up of preventive public health measures, and other unidentified factors that should be investigated.

Potential limitations of this study include the fact that population-based random sampling was not used, and the results cannot be truly extrapolated to the general population. Also, a simple rapid assay was used, and this may be less sensitive than enzyme-linked immunosorbent assays to detect SARS-CoV-2 antibodies. Finally, antibodies decay over time, which can lead to underestimation of seroprevalence.

Acknowledgements

The authors wish to thank all the study participants, medical staff and the Congolese national health authorities for providing research authorizations.

Conflict of interest statement

None declared.

Funding

This work was funded by the French National Agency for Research on HIV/AIDS, viral hepatitis and emerging infectious diseases (ANRS I MIE) under Grant No. ANRSCOV12.

Ethical approval

The study protocol was approved by the National Ethics Committee (Authorization 343/MRSIT/IRSSA/CERSSA).

References

Adetifa IMO, Uyogo S, Gitonga JN, Mugo D, Otiende M, Nyagwango J, et al. Temporal trends of SARS-CoV-2 seroprevalence during the first wave of the COVID-19 epidemic in Kenya. Nat Commun 2021;12:3966.
Angulo FJ, Finelli L, Swerdlow DL. Estimation of US SARS-CoV-2 infections, symptomatic infections, hospitalizations, and deaths using seroprevalence surveys. JAMA Netw Open 2021;4.
Bonguili NCB, Fritz M, Lenguïya LH, Mayengue PI, Koukouikila-Koussounda F, Douxou Yofo JB, et al. Early circulation of SARS-CoV-2, Congo. 2020. Emerg Infect Dis 2022;28:878–80.
Gignoux E, Athanassiadis F, Garat Yarrow A, Jimale A, Mubuto N, Deglié C, et al. Seroprevalence of SARS-CoV-2 antibodies and retrospective mortality in a refugee camp, Dgahaley, Kenya. PloS One 2021;16.
Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet 2020;395:497–506.
Mulenga LB, Hines JZ, Fwoolosi S, Chirwa L, Sisingwa M, Yingst S, et al. Prevalence of SARS-CoV-2 in six districts in Zambia, July, 2020: a cross-sectional cluster sample survey. Lancet Glob Health 2021;9:e773–81.
Ngere I, Dawa J, Hunsperger E, Otiemo N, Matika M, Amoth P, et al. High seroprevalence of SARS-CoV-2 but low infection fatality ratio eight months after introduction in Nairobi, Kenya. Int J Infect Dis 2021;112:25–34.
Pere H, Mboumba Bouana BS, Tonon-Woye S, Podglajen I, Veyer D, Belec L. Analytical performances of five SARS-CoV-2 whole-blood finger-stick IgG-IgM combined antibody rapid tests. J Virol Meth 2021;290.
Pourstchi H, Darvishian M, Mohammadi Z, Shayanrad A, Delavari A, Bahadorinimafar A, et al. SARS-CoV-2 antibody seroprevalence in the general population and high-risk occupational groups across 18 cities in Iran: a population-based cross-sectional study. Lancet Infect Dis 2021;21:473–81.
R Core Team. R: a language and environment for statistical computing. Vienna: R Foundation for Statistical Computing; 2020.
WHO. WHO coronavirus (COVID-19) dashboard. Situation by region, country, territory & area. Geneva: World Health Organization; 2022 Available at https://covid19.who.int/table last accessed July 2022.