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SARS-CoV-2 Antibody Seroprevalence in Yaounde, Cameroon

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# Summary

## Background

The COVID-19 pandemic has led to severe strains on health systems and unprecedented levels of societal disruption. While Sub-Saharan Africa has not been completely spared, the epidemic in this region appears to have been relatively less severe. The reasons for the mitigated impact are not fully understood. An adequate view will include accurate assessments of populations’ exposure to the virus and the typical manifestations of infection.

## Methods

We conducted a cross-sectional, community-based serosurvey in the densely populated health district (Cité Verte) of the city of Yaoundé, the capital of Cameroon, from 14 October to 26 November 2020. Households were randomly selected from the OpenStreetMap building footprint, and residents between 5 and 80 years of age were surveyed in each household. The Abbott Panbio IgM/IgG SARS-CoV-2 rapid antibody test was administered along with a questionnaire on disease symptoms, health-seeking behaviour and pandemic effects. Final seroprevalence estimates were reweighted based on the age-sex distribution of the Yaoundé population and adjusted for test specificity and sensitivity.

## Findings

SARS-CoV-2 appears to have circulated widely in the city of Yaoundé, affecting about a third of the population in the *Cité Verte* district (adjusted IgG seroprevalence: 29.2% [24.3% - 34.1%]). More than 60% of those with antibodies reported having no acute symptoms during the pandemic period, and only one individual reported a COVID-19-related hospitalisation. In addition to the serious spread of the disease, the economic impact was also severe, with 85% of households reporting a decline in household income over the pandemic period.

## Interpretation

The observed anti-SARS-CoV-2 IgG seroprevalence seen in Cité Verte is much higher than suggested by official case counts...implying greater than 98% of infections went undiagnosed and unreported. The low rate of symptomatic infection and hospitalization indicate a relatively mild disease manifestation in this population. Given the low testing, some of these should be taken with some skepticism.

The widely reported reductions in household income may affect other health outcomes.

## Funding

German Corporation for International Cooperation (GmbH) and Canton Geneva.

# Research in context (special section for Lancet)

## Evidence before this study

We searched PubMed for relevant preprints or published papers available as at Feb 14, 2020. We used the search terms “SARS-CoV-2”, “seroprevalence” or “antibodies”, and “Africa” and read the abstracts of the 25 returned papers. We also consulted the University of Calgary SeroTracker ([*https://serotracker.com/en/Explore*](https://serotracker.com/en/Explore)), which highlights ongoing and concluded serosurveys.

To date, very few studies have assessed the SARS-CoV-2 antibody seroprevalence in Sub-Saharan African countries. The majority of published surveys have been performed on healthcare workers and other special populations. These have found quite high seroprevalences, much higher than would be

The only studies among the lay population have been in Niger State, Nigeria (which shows a 25.4% IgG seroprevalence in June, 2020, blood donors in Kenya (population-weighted seroprevalence of 4.3% in April-June) and blood donors in South Africa

## Added value of this study

This study is one of the first to assess the prior exposure to SARS-CoV-2 of a random sample of residents of an African country. We used building footprint sampling to randomly select survey participants, and used the lateral-flow Abbot PanBio SARS-CoV-2 IgG/IgM test to assess SARS-CoV-2 seroprevalence. Our findings indicate a relatively high seroprevalence (IgG: 29.2%) and a relatively low level of symptomatic infection (< 40%).

## Implications of all the available evidence

Our findings, along with others reported on the continent, show that official PCR-confirmed case reports are a manyfold underestimate of the population that SARS-CoV-2 infection in African countries. The data point towards a widespread, but largely asymptomatic epidemic in cities across the continent.

In contrast to what has been found in other regions, seroprevalence here appears to increase with age, with the highest seroprevalence seen among those above 65 years of age. This may reflect the slower waning of the antibody response in these respondents.

This study fills an important gap in the knowledge of the burden of COVID-19 in Cameroon, providing the first data on a random sample of households in the country, and one of the first in the African continent.

# Introduction

Given the serious health burden caused by the COVID-19 pandemic in countries with the richest health systems, the initial outlook for the less developed regions, and Sub-Saharan Africa in particular, seemed dire. Severe disease burdens were expected due to weaknesses in health systems, difficulties in implementing hygiene measures, and perceived public health vulnerabilities.[ITEM CSL\_CITATION {"citationID":"ZJ5l3Lk5","properties":{"formattedCitation":"\\super 1\\nosupersub{}","plainCitation":"1","noteIndex":0},"citationItems":[{"id":31,"uris":["http://zotero.org/users/6990598/items/P2L2SWYS"],"uri":["http://zotero.org/users/6990598/items/P2L2SWYS"],"itemData":{"id":31,"type":"webpage","abstract":"There has been 200 suspected cases on the continent but nearly all have been confirmed negative.","container-title":"TheJournal.ie","language":"en","title":"WHO warns Africa is ill-equipped to deal with coronavirus due to 'weaker health systems'","URL":"https://www.thejournal.ie/world-health-organisation-african-coronavirus-5017867-Feb2020/","author":[{"family":"AFP","given":""}],"accessed":{"date-parts":[["2020",12,8]]}}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}](https://www.zotero.org/),[ITEM CSL\_CITATION {"citationID":"XwGmshBT","properties":{"formattedCitation":"\\super 2\\nosupersub{}","plainCitation":"2","noteIndex":0},"citationItems":[{"id":33,"uris":["http://zotero.org/users/6990598/items/MNNEL83N"],"uri":["http://zotero.org/users/6990598/items/MNNEL83N"],"itemData":{"id":33,"type":"article-journal","abstract":"Emerging highly transmissible viral infections such as SARS-CoV-2 pose a significant global threat to human health and the economy. Since its first appearance in December 2019 in the city of Wuhan, Hubei province, China, SARS-CoV-2 infection has quickly spread across the globe, with the first case reported on the African continent, in Egypt on February 14\nth, 2020. Although the global number of COVID-19 infections has increased exponentially since the beginning of the pandemic, the number of new infections and deaths recorded in African countries have been relatively modest, suggesting slower transmission dynamics of the virus on the continent, a lower case fatality rate, or simply a lack of testing or reliable data. Notably, there is no significant increase in unexplained pneumonias or deaths on the continent which could possibly indicate the effectiveness of interventions introduced by several African governments. However, there has not yet been a comprehensive assessment of sub-Saharan Africa’s (SSA) preparedness and response to the COVID-19 pandemic that may have contributed to prevent an uncontrolled outbreak so far. As a group of early career scientists and the next generation of African scientific leaders with experience of working in medical and diverse health research fields in both SSA and resource-rich countries, we present a unique perspective on the current public health interventions to fight COVID-19 in Africa. Our perspective is based on extensive review of the available scientific publications, official technical reports and announcements released by governmental and non-governmental health organizations as well as from our personal experiences as workers on the COVID-19 battlefield in SSA. We documented public health interventions implemented in seven SSA countries including Uganda, Kenya, Rwanda, Cameroon, Zambia, South Africa and Botswana, the existing gaps and the important components of disease control that may strengthen SSA response to future outbreaks.","container-title":"Wellcome Open Research","DOI":"10.12688/wellcomeopenres.16070.2","ISSN":"2398-502X","journalAbbreviation":"Wellcome Open Res","note":"PMID: 32984549\nPMCID: PMC7499400","source":"PubMed Central","title":"Sub-Saharan Africa preparedness and response to the COVID-19 pandemic: A perspective of early career African scientists","title-short":"Sub-Saharan Africa preparedness and response to the COVID-19 pandemic","URL":"https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7499400/","volume":"5","author":[{"family":"Umviligihozo","given":"Gisele"},{"family":"Mupfumi","given":"Lucy"},{"family":"Sonela","given":"Nelson"},{"family":"Naicker","given":"Delon"},{"family":"Obuku","given":"Ekwaro A."},{"family":"Koofhethile","given":"Catherine"},{"family":"Mogashoa","given":"Tuelo"},{"family":"Kapaata","given":"Anne"},{"family":"Ombati","given":"Geoffrey"},{"family":"Michelo","given":"Clive M."},{"family":"Makobu","given":"Kimani"},{"family":"Todowede","given":"Olamide"},{"family":"Balinda","given":"Sheila N."}],"accessed":{"date-parts":[["2020",12,8]]},"issued":{"date-parts":[["2020",9,16]]}}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}](https://www.zotero.org/) However, reported cases and death figures suggest that the continent's epidemic path has been relatively mild. By 12 February 2020, South Africa was the only SSA county to have reported more than 3000 COVID-19 deaths.[ITEM CSL\_CITATION {"citationID":"a22orr7a9fn","properties":{"formattedCitation":"\\super 3\\nosupersub{}","plainCitation":"3","noteIndex":0},"citationItems":[{"id":117,"uris":["http://zotero.org/users/6990598/items/2VXUA86D"],"uri":["http://zotero.org/users/6990598/items/2VXUA86D"],"itemData":{"id":117,"type":"article-journal","abstract":"In December, 2019, a local outbreak of pneumonia of initially unknown cause was detected\nin Wuhan (Hubei, China), and was quickly determined to be caused by a novel coronavirus,1\nnamely severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The outbreak\nhas since spread to every province of mainland China as well as 27 other countries\nand regions, with more than 70 000 confirmed cases as of Feb 17, 2020.2 In response\nto this ongoing public health emergency, we developed an online interactive dashboard,\nhosted by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University,\nBaltimore, MD, USA, to visualise and track reported cases of coronavirus disease 2019\n(COVID-19) in real time.","container-title":"The Lancet Infectious Diseases","DOI":"10.1016/S1473-3099(20)30120-1","ISSN":"1473-3099, 1474-4457","issue":"5","journalAbbreviation":"The Lancet Infectious Diseases","language":"English","note":"publisher: Elsevier\nPMID: 32087114","page":"533-534","source":"www.thelancet.com","title":"An interactive web-based dashboard to track COVID-19 in real time","volume":"20","author":[{"family":"Dong","given":"Ensheng"},{"family":"Du","given":"Hongru"},{"family":"Gardner","given":"Lauren"}],"issued":{"date-parts":[["2020",5,1]]}}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}](https://www.zotero.org/) By that date, Cameroon had reported only 32000 cases and 479 deaths, implying a COVID-19 fatality per million of 18.0 (as compared with the 1146 deaths per million seen in the European Union).

Multiple hypotheses have been advanced to explain the seemingly mild trajectory of the COVID-19 epidemic in Africa: researchers have pointed to warm climate conditions across sub-Saharan Africa (apart from South-Africa), the continent’s young population (median age of 19 years), and cross-reactive immunity from other infections as possible mitigating factors.[ITEM CSL\_CITATION {"citationID":"WtQZYOpg","properties":{"formattedCitation":"\\super 2\\nosupersub{}","plainCitation":"2","noteIndex":0},"citationItems":[{"id":33,"uris":["http://zotero.org/users/6990598/items/MNNEL83N"],"uri":["http://zotero.org/users/6990598/items/MNNEL83N"],"itemData":{"id":33,"type":"article-journal","abstract":"Emerging highly transmissible viral infections such as SARS-CoV-2 pose a significant global threat to human health and the economy. Since its first appearance in December 2019 in the city of Wuhan, Hubei province, China, SARS-CoV-2 infection has quickly spread across the globe, with the first case reported on the African continent, in Egypt on February 14\nth, 2020. Although the global number of COVID-19 infections has increased exponentially since the beginning of the pandemic, the number of new infections and deaths recorded in African countries have been relatively modest, suggesting slower transmission dynamics of the virus on the continent, a lower case fatality rate, or simply a lack of testing or reliable data. Notably, there is no significant increase in unexplained pneumonias or deaths on the continent which could possibly indicate the effectiveness of interventions introduced by several African governments. However, there has not yet been a comprehensive assessment of sub-Saharan Africa’s (SSA) preparedness and response to the COVID-19 pandemic that may have contributed to prevent an uncontrolled outbreak so far. As a group of early career scientists and the next generation of African scientific leaders with experience of working in medical and diverse health research fields in both SSA and resource-rich countries, we present a unique perspective on the current public health interventions to fight COVID-19 in Africa. Our perspective is based on extensive review of the available scientific publications, official technical reports and announcements released by governmental and non-governmental health organizations as well as from our personal experiences as workers on the COVID-19 battlefield in SSA. We documented public health interventions implemented in seven SSA countries including Uganda, Kenya, Rwanda, Cameroon, Zambia, South Africa and Botswana, the existing gaps and the important components of disease control that may strengthen SSA response to future outbreaks.","container-title":"Wellcome Open Research","DOI":"10.12688/wellcomeopenres.16070.2","ISSN":"2398-502X","journalAbbreviation":"Wellcome Open Res","note":"PMID: 32984549\nPMCID: PMC7499400","source":"PubMed Central","title":"Sub-Saharan Africa preparedness and response to the COVID-19 pandemic: A perspective of early career African scientists","title-short":"Sub-Saharan Africa preparedness and response to the COVID-19 pandemic","URL":"https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7499400/","volume":"5","author":[{"family":"Umviligihozo","given":"Gisele"},{"family":"Mupfumi","given":"Lucy"},{"family":"Sonela","given":"Nelson"},{"family":"Naicker","given":"Delon"},{"family":"Obuku","given":"Ekwaro A."},{"family":"Koofhethile","given":"Catherine"},{"family":"Mogashoa","given":"Tuelo"},{"family":"Kapaata","given":"Anne"},{"family":"Ombati","given":"Geoffrey"},{"family":"Michelo","given":"Clive M."},{"family":"Makobu","given":"Kimani"},{"family":"Todowede","given":"Olamide"},{"family":"Balinda","given":"Sheila N."}],"accessed":{"date-parts":[["2020",12,8]]},"issued":{"date-parts":[["2020",9,16]]}}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}](https://www.zotero.org/)

But a sufficient answer to this question requires accurate estimates of the true extent of viral spread. As has been observed elsewhere,[ITEM CSL\_CITATION {"citationID":"68rP30UC","properties":{"formattedCitation":"\\super 4\\nosupersub{}","plainCitation":"4","noteIndex":0},"citationItems":[{"id":38,"uris":["http://zotero.org/users/6990598/items/WKDVRLWT"],"uri":["http://zotero.org/users/6990598/items/WKDVRLWT"],"itemData":{"id":38,"type":"article-journal","abstract":"<h2>Summary</h2><h3>Background</h3><p>Assessing the burden of COVID-19 on the basis of medically attended case numbers is suboptimal given its reliance on testing strategy, changing case definitions, and disease presentation. Population-based serosurveys measuring anti-severe acute respiratory syndrome coronavirus 2 (anti-SARS-CoV-2) antibodies provide one method for estimating infection rates and monitoring the progression of the epidemic. Here, we estimate weekly seroprevalence of anti-SARS-CoV-2 antibodies in the population of Geneva, Switzerland, during the epidemic.</p><h3>Methods</h3><p>The SEROCoV-POP study is a population-based study of former participants of the Bus Santé study and their household members. We planned a series of 12 consecutive weekly serosurveys among randomly selected participants from a previous population-representative survey, and their household members aged 5 years and older. We tested each participant for anti-SARS-CoV-2-IgG antibodies using a commercially available ELISA. We estimated seroprevalence using a Bayesian logistic regression model taking into account test performance and adjusting for the age and sex of Geneva's population. Here we present results from the first 5 weeks of the study.</p><h3>Findings</h3><p>Between April 6 and May 9, 2020, we enrolled 2766 participants from 1339 households, with a demographic distribution similar to that of the canton of Geneva. In the first week, we estimated a seroprevalence of 4·8% (95% CI 2·4–8·0, n=341). The estimate increased to 8·5% (5·9–11·4, n=469) in the second week, to 10·9% (7·9–14·4, n=577) in the third week, 6·6% (4·3–9·4, n=604) in the fourth week, and 10·8% (8·2–13·9, n=775) in the fifth week. Individuals aged 5–9 years (relative risk [RR] 0·32 [95% CI 0·11–0·63]) and those older than 65 years (RR 0·50 [0·28–0·78]) had a significantly lower risk of being seropositive than those aged 20–49 years. After accounting for the time to seroconversion, we estimated that for every reported confirmed case, there were 11·6 infections in the community.</p><h3>Interpretation</h3><p>These results suggest that most of the population of Geneva remained uninfected during this wave of the pandemic, despite the high prevalence of COVID-19 in the region (5000 reported clinical cases over <2·5 months in the population of half a million people). Assuming that the presence of IgG antibodies is associated with immunity, these results highlight that the epidemic is far from coming to an end by means of fewer susceptible people in the population. Further, a significantly lower seroprevalence was observed for children aged 5–9 years and adults older than 65 years, compared with those aged 10–64 years. These results will inform countries considering the easing of restrictions aimed at curbing transmission.</p><h3>Funding</h3><p>Swiss Federal Office of Public Health, Swiss School of Public Health (Corona Immunitas research program), Fondation de Bienfaisance du Groupe Pictet, Fondation Ancrage, Fondation Privée des Hôpitaux Universitaires de Genève, and Center for Emerging Viral Diseases.</p>","container-title":"The Lancet","DOI":"10.1016/S0140-6736(20)31304-0","ISSN":"0140-6736, 1474-547X","issue":"10247","journalAbbreviation":"The Lancet","language":"English","note":"publisher: Elsevier\nPMID: 32534626","page":"313-319","source":"www.thelancet.com","title":"Seroprevalence of anti-SARS-CoV-2 IgG antibodies in Geneva, Switzerland (SEROCoV-POP): a population-based study","title-short":"Seroprevalence of anti-SARS-CoV-2 IgG antibodies in Geneva, Switzerland (SEROCoV-POP)","volume":"396","author":[{"family":"Stringhini","given":"Silvia"},{"family":"Wisniak","given":"Ania"},{"family":"Piumatti","given":"Giovanni"},{"family":"Azman","given":"Andrew S."},{"family":"Lauer","given":"Stephen A."},{"family":"Baysson","given":"Hélène"},{"family":"Ridder","given":"David De"},{"family":"Petrovic","given":"Dusan"},{"family":"Schrempft","given":"Stephanie"},{"family":"Marcus","given":"Kailing"},{"family":"Yerly","given":"Sabine"},{"family":"Vernez","given":"Isabelle Arm"},{"family":"Keiser","given":"Olivia"},{"family":"Hurst","given":"Samia"},{"family":"Posfay-Barbe","given":"Klara M."},{"family":"Trono","given":"Didier"},{"family":"Pittet","given":"Didier"},{"family":"Gétaz","given":"Laurent"},{"family":"Chappuis","given":"François"},{"family":"Eckerle","given":"Isabella"},{"family":"Vuilleumier","given":"Nicolas"},{"family":"Meyer","given":"Benjamin"},{"family":"Flahault","given":"Antoine"},{"family":"Kaiser","given":"Laurent"},{"family":"Guessous","given":"Idris"}],"issued":{"date-parts":[["2020",8,1]]}}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}](https://www.zotero.org/) the officially reported case counts may significantly underestimate the extent of the viral propagation.[ITEM CSL\_CITATION {"citationID":"epBNjjkc","properties":{"formattedCitation":"\\super 2\\nosupersub{}","plainCitation":"2","noteIndex":0},"citationItems":[{"id":33,"uris":["http://zotero.org/users/6990598/items/MNNEL83N"],"uri":["http://zotero.org/users/6990598/items/MNNEL83N"],"itemData":{"id":33,"type":"article-journal","abstract":"Emerging highly transmissible viral infections such as SARS-CoV-2 pose a significant global threat to human health and the economy. 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However, there has not yet been a comprehensive assessment of sub-Saharan Africa’s (SSA) preparedness and response to the COVID-19 pandemic that may have contributed to prevent an uncontrolled outbreak so far. As a group of early career scientists and the next generation of African scientific leaders with experience of working in medical and diverse health research fields in both SSA and resource-rich countries, we present a unique perspective on the current public health interventions to fight COVID-19 in Africa. Our perspective is based on extensive review of the available scientific publications, official technical reports and announcements released by governmental and non-governmental health organizations as well as from our personal experiences as workers on the COVID-19 battlefield in SSA. We documented public health interventions implemented in seven SSA countries including Uganda, Kenya, Rwanda, Cameroon, Zambia, South Africa and Botswana, the existing gaps and the important components of disease control that may strengthen SSA response to future outbreaks.","container-title":"Wellcome Open Research","DOI":"10.12688/wellcomeopenres.16070.2","ISSN":"2398-502X","journalAbbreviation":"Wellcome Open Res","note":"PMID: 32984549\nPMCID: PMC7499400","source":"PubMed Central","title":"Sub-Saharan Africa preparedness and response to the COVID-19 pandemic: A perspective of early career African scientists","title-short":"Sub-Saharan Africa preparedness and response to the COVID-19 pandemic","URL":"https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7499400/","volume":"5","author":[{"family":"Umviligihozo","given":"Gisele"},{"family":"Mupfumi","given":"Lucy"},{"family":"Sonela","given":"Nelson"},{"family":"Naicker","given":"Delon"},{"family":"Obuku","given":"Ekwaro A."},{"family":"Koofhethile","given":"Catherine"},{"family":"Mogashoa","given":"Tuelo"},{"family":"Kapaata","given":"Anne"},{"family":"Ombati","given":"Geoffrey"},{"family":"Michelo","given":"Clive M."},{"family":"Makobu","given":"Kimani"},{"family":"Todowede","given":"Olamide"},{"family":"Balinda","given":"Sheila N."}],"accessed":{"date-parts":[["2020",12,8]]},"issued":{"date-parts":[["2020",9,16]]}}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}](https://www.zotero.org/) In this context, the use of serological antibody tests to detect exposure to SARS-CoV-2 is valuable. Such surveys allow us to ascertain whether the spread of the virus largely impeded, or whether there has been widespread exposure to the virus, with minimal exhibition of clinical symptoms.

So far, there have been only a few serological studies on the continent. These include a study of blood banks in Kenya in April-June 2020, which showed an IgG seroprevalence of 4.3% (2.9% to 5.8%)[ITEM CSL\_CITATION {"citationID":"gXu9Yuxo","properties":{"formattedCitation":"\\super 5\\nosupersub{}","plainCitation":"5","noteIndex":0},"citationItems":[{"id":103,"uris":["http://zotero.org/users/6990598/items/JGTFSUST"],"uri":["http://zotero.org/users/6990598/items/JGTFSUST"],"itemData":{"id":103,"type":"article-journal","abstract":"Pandemic progress in Kenya\nBy the end of July 2020, Kenya had reported only 341 deaths and ∼20,000 cases of COVID-19. This is in marked contrast to the tens of thousands of deaths reported in many higher-income countries. The true extent of COVID-19 in the community was unknown and likely to be higher than reports indicated. Uyoga et al. found an overall seroprevalence among blood donors of 4.3%, peaking in 35- to 44-year-old individuals (see the Perspective by Maeda and Nkengasong). The low mortality can be partly explained by the steep demographics in Kenya, where less than 4% of the population is 65 or older. These circumstances combine to result in Kenyan hospitals not currently being overwhelmed by patients with respiratory distress. However, the imposition of a strict lockdown in this country has shifted the disease burden to maternal and child deaths as a result of disruption to essential medical services.\nScience, this issue p. 79; see also p. 27\nThe spread of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in Africa is poorly described. The first case of SARS-CoV-2 in Kenya was reported on 12 March 2020, and an overwhelming number of cases and deaths were expected, but by 31 July 2020, there were only 20,636 cases and 341 deaths. However, the extent of SARS-CoV-2 exposure in the community remains unknown. We determined the prevalence of anti–SARS-CoV-2 immunoglobulin G among blood donors in Kenya in April–June 2020. Crude seroprevalence was 5.6% (174 of 3098). Population-weighted, test-performance-adjusted national seroprevalence was 4.3% (95% confidence interval, 2.9 to 5.8%) and was highest in urban counties Mombasa (8.0%), Nairobi (7.3%), and Kisumu (5.5%). SARS-CoV-2 exposure is more extensive than indicated by case-based surveillance, and these results will help guide the pandemic response in Kenya and across Africa.\nBy May 2020, 1 in 20 Kenyan adults had SARS-CoV-2 antibodies, when fewer than 100 COVID-19 deaths had been reported nationally.\nBy May 2020, 1 in 20 Kenyan adults had SARS-CoV-2 antibodies, when fewer than 100 COVID-19 deaths had been reported nationally.","container-title":"Science","DOI":"10.1126/science.abe1916","ISSN":"0036-8075, 1095-9203","issue":"6524","language":"en","note":"publisher: American Association for the Advancement of Science\nsection: Report\nPMID: 33177105","page":"79-82","source":"science.sciencemag.org","title":"Seroprevalence of anti–SARS-CoV-2 IgG antibodies in Kenyan blood donors","volume":"371","author":[{"family":"Uyoga","given":"Sophie"},{"family":"Adetifa","given":"Ifedayo M. O."},{"family":"Karanja","given":"Henry K."},{"family":"Nyagwange","given":"James"},{"family":"Tuju","given":"James"},{"family":"Wanjiku","given":"Perpetual"},{"family":"Aman","given":"Rashid"},{"family":"Mwangangi","given":"Mercy"},{"family":"Amoth","given":"Patrick"},{"family":"Kasera","given":"Kadondi"},{"family":"Ng’ang’a","given":"Wangari"},{"family":"Rombo","given":"Charles"},{"family":"Yegon","given":"Christine"},{"family":"Kithi","given":"Khamisi"},{"family":"Odhiambo","given":"Elizabeth"},{"family":"Rotich","given":"Thomas"},{"family":"Orgut","given":"Irene"},{"family":"Kihara","given":"Sammy"},{"family":"Otiende","given":"Mark"},{"family":"Bottomley","given":"Christian"},{"family":"Mupe","given":"Zonia N."},{"family":"Kagucia","given":"Eunice W."},{"family":"Gallagher","given":"Katherine E."},{"family":"Etyang","given":"Anthony"},{"family":"Voller","given":"Shirine"},{"family":"Gitonga","given":"John N."},{"family":"Mugo","given":"Daisy"},{"family":"Agoti","given":"Charles N."},{"family":"Otieno","given":"Edward"},{"family":"Ndwiga","given":"Leonard"},{"family":"Lambe","given":"Teresa"},{"family":"Wright","given":"Daniel"},{"family":"Barasa","given":"Edwine"},{"family":"Tsofa","given":"Benjamin"},{"family":"Bejon","given":"Philip"},{"family":"Ochola-Oyier","given":"Lynette I."},{"family":"Agweyu","given":"Ambrose"},{"family":"Scott","given":"J. Anthony G."},{"family":"Warimwe","given":"George M."}],"issued":{"date-parts":[["2021",1,1]]}}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}](https://www.zotero.org/), or from Niger State in Nigeria in June 2020 which showed a seroprevalence of 25.4%[ITEM CSL\_CITATION {"citationID":"a168llr0jti","properties":{"formattedCitation":"\\super 6\\nosupersub{}","plainCitation":"6","noteIndex":0},"citationItems":[{"id":112,"uris":["http://zotero.org/users/6990598/items/HNFZP5GJ"],"uri":["http://zotero.org/users/6990598/items/HNFZP5GJ"],"itemData":{"id":112,"type":"article-journal","abstract":"<h3>Abstract</h3> <p>Coronavirus Disease 2019 (COVID-19) Pandemic is ongoing, and to know how far the virus has spread in Niger State, Nigeria, a pilot study was carried out to determine the COVID-19 seroprevalence, patterns, dynamics, and risk factors in the state. A cross sectional study design and clustered-stratified-Random sampling strategy were used. COVID-19 IgG and IgM Rapid Test Kits (Colloidal gold immunochromatography lateral flow system) were used to determine the presence or absence of antibodies to SARS-CoV-2 in the blood of sampled participants across Niger State as from 26<sup>th</sup> June 2020 to 30<sup>th</sup> June 2020. The test kits were validated using the blood samples of some of the NCDC confirmed positive and negative COVID-19 cases in the State. COVID-19 IgG and IgM Test results were entered into the EPIINFO questionnaire administered simultaneously with each test. EPIINFO was then used for both the descriptive and inferential statistical analyses of the data generated. The seroprevalence of COVID-19 in Niger State was found to be 25.41% and 2.16% for the positive IgG and IgM respectively. Seroprevalence among age groups, gender and by occupation varied widely. A seroprevalence of 37.21% was recorded among health care workers in Niger State. Among age groups, COVID-19 seroprevalence was found to be in order of 30-41 years (33.33%) &gt; 42-53 years (32.42%) &gt; 54-65 years (30%) &gt; 66 years and above (25%) &gt; 6-17 years (19.20%) &gt; 18-29 years (17.65%) &gt; 5 years and below (6.66%). A seroprevalence of 27.18% was recorded for males and 23.17% for females in the state. COVID-19 asymptomatic rate in the state was found to be 46.81%. The risk analyses showed that the chances of infection are almost the same for both urban and rural dwellers in the state. However, health care workers and those that have had contact with person (s) that travelled out of Nigeria in the last six (6) months are twice (2 times) at risk of being infected with the virus. More than half (54.59%) of the participants in this study did not practice social distancing at any time since the pandemic started. Discussions about knowledge, practice and attitude of the participants are included. The observed Niger State COVID-19 seroprevalence means that the herd immunity for COVID-19 is yet to be achieved and the population is still susceptible for more infection and transmission of the virus. If the prevalence stays as reported here, the population will definitely need COVID-19 vaccines when they become available. Niger State should fully enforce the use of face/nose masks and observation of social/physical distancing in gatherings including religious gatherings in order to stop or slow the spread of the virus.</p>","container-title":"medRxiv","DOI":"10.1101/2020.08.04.20168112","language":"en","note":"publisher: Cold Spring Harbor Laboratory Press","page":"2020.08.04.20168112","source":"www.medrxiv.org","title":"Seroprevalence of COVID-19 in Niger State","author":[{"family":"Majiya","given":"H."},{"family":"Aliyu-Paiko","given":"M."},{"family":"Balogu","given":"V. T."},{"family":"Musa","given":"D. A."},{"family":"Salihu","given":"I. M."},{"family":"Kawu","given":"A. A."},{"family":"Bashir","given":"Y. I."},{"family":"Sani","given":"R. A."},{"family":"Baba","given":"J."},{"family":"Muhammad","given":"A. T."},{"family":"Jibril","given":"F. L."},{"family":"Bala","given":"E."},{"family":"Obaje","given":"N. G."},{"family":"Aliyu","given":"B. Y."},{"family":"Muhammad","given":"R. G."},{"family":"Mohammed","given":"H."},{"family":"Gimba","given":"N. U."},{"family":"Uthman","given":"A."},{"family":"Liman","given":"H. M."},{"family":"Sule","given":"A. A."},{"family":"Joseph","given":"K. J."},{"family":"Makusidi","given":"M. M."},{"family":"Isah","given":"M. D."},{"family":"Abdullahi","given":"I."},{"family":"Ndagi","given":"U."},{"family":"Waziri","given":"B."},{"family":"Bisallah","given":"C. I."},{"family":"Dadi-Mamud","given":"N. J."},{"family":"Ibrahim","given":"K."},{"family":"Adamu","given":"A. K."}],"issued":{"date-parts":[["2020",8,5]]}}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}](https://www.zotero.org/), one from healthcare workers in Ibadan 45%[ITEM CSL\_CITATION {"citationID":"R0OLpYHd","properties":{"formattedCitation":"\\super 7\\nosupersub{}","plainCitation":"7","noteIndex":0},"citationItems":[{"id":99,"uris":["http://zotero.org/users/6990598/items/MFFA2NRT"],"uri":["http://zotero.org/users/6990598/items/MFFA2NRT"],"itemData":{"id":99,"type":"article-journal","abstract":"Global health has been thrown into turmoil by the COVID-19 pandemic, which has caused devastating morbidity and unprecedented loss of life in almost all continents of the world. It was predicted that the magnitude of the pandemic in Africa will be high because of poor health structure and intensely poor living condition, but that has not happened, surprisingly. It was hypothesized that the youthful population and a vastly primed immune system were protective, and many people may have been exposed without coming down with the severe disease. Most of them would have presented in hospitals with other medical conditions and possibly transmit COVID-19 to health workers inadvertently. This study is designed to measure serum SARS-CoV-2 IgG levels in health workers as a marker of latent exposure. Asymptomatic frontline health workers were randomly selected from the University College Hospital Ibadan, Nigeria; venous blood samples were obtained from them, and the serum SARS-CoV-2 IgG level was determined using ELISA techniques. A proportion of participants with seropositivity were obtained, and factors associated with seropositivity were determined. A total of 133 participants were recruited for this study, and 60 (45.1%) of them were seropositive for SARS-CoV-2. Among the seropositive participants were doctors, nurses, health assistants, laboratory scientists and technicians, and nonmedical staff. Obstetrics, gynecology, and emergency departments had higher odds of seropositivity. Seroprevalence of SARS-CoV-2 is very high among frontline health workers, though asymptomatic. This calls for a more stringent precaution against further spread within the hospital environment.","container-title":"The American Journal of Tropical Medicine and Hygiene","DOI":"10.4269/ajtmh.20-1235","ISSN":"1476-1645","issue":"1","journalAbbreviation":"Am J Trop Med Hyg","language":"eng","note":"PMID: 33185181\nPMCID: PMC7790104","page":"91-94","source":"PubMed","title":"SARS-CoV-2 Seropositivity in Asymptomatic Frontline Health Workers in Ibadan, Nigeria","volume":"104","author":[{"family":"Olayanju","given":"Olatunde"},{"family":"Bamidele","given":"Olabisi"},{"family":"Edem","given":"Fabian"},{"family":"Eseile","given":"Bola"},{"family":"Amoo","given":"Abimbola"},{"family":"Nwaokenye","given":"Jude"},{"family":"Udeh","given":"Chioma"},{"family":"Oluwole","given":"Gabriel"},{"family":"Odok","given":"Gabriel"},{"family":"Awah","given":"Nnaemeka"}],"issued":{"date-parts":[["2021",1]]}}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}](https://www.zotero.org/) , healthcare workers in urban Malawi in May-June 2020 showed an IgG seroprevalence of 12.3% (8.2% to 16.5%)[ITEM CSL\_CITATION {"citationID":"9yQ1ocki","properties":{"formattedCitation":"\\super 8\\nosupersub{}","plainCitation":"8","noteIndex":0},"citationItems":[{"id":107,"uris":["http://zotero.org/users/6990598/items/X8MK9N7N"],"uri":["http://zotero.org/users/6990598/items/X8MK9N7N"],"itemData":{"id":107,"type":"article-journal","abstract":"<p>Background: In low-income countries, like Malawi, important public health measures including social distancing or a lockdown have been challenging to implement owing to socioeconomic constraints, leading to predictions that the COVID-19 pandemic would progress rapidly. However, due to limited capacity to test for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection, there are no reliable estimates of the true burden of infection and death. We, therefore, conducted a SARS-CoV-2 serosurvey amongst health care workers (HCWs) in Blantyre city to estimate the cumulative incidence of SARS-CoV-2 infection in urban Malawi. Methods: We recruited 500 otherwise asymptomatic HCWs from Blantyre City (Malawi) from 22nd May 2020 to 19th June 2020 and serum samples were collected from all participants. A commercial ELISA was used to measure SARS-CoV-2 IgG antibodies in serum. Results: A total of 84 participants tested positive for SARS-CoV-2 antibodies. The HCWs with positive SARS-CoV-2 antibody results came from different parts of the city. The adjusted seroprevalence of SARS-CoV-2 antibodies was 12.3% [CI 8.2 - 16.5]. Using age-stratified infection fatality estimates reported from elsewhere, we found that at the observed adjusted seroprevalence, the number of predicted deaths was eight times the number of reported deaths. Conclusions: The high seroprevalence of SARS-CoV-2 antibodies among HCWs and the discrepancy in the predicted versus reported deaths suggests that there was early exposure but slow progression of COVID-19 epidemic in urban Malawi. This highlights the urgent need for development of locally parameterised mathematical models to more accurately predict the trajectory of the epidemic in sub-Saharan Africa for better evidence-based policy decisions and public health response planning.</p>","container-title":"medRxiv","DOI":"10.1101/2020.07.30.20164970","language":"en","note":"publisher: Cold Spring Harbor Laboratory Press","page":"2020.07.30.20164970","source":"www.medrxiv.org","title":"High SARS-CoV-2 seroprevalence in health care workers but relatively low numbers of deaths in urban Malawi","author":[{"family":"Chibwana","given":"Marah G."},{"family":"Jere","given":"Khuzwayo C."},{"family":"Kamn’gona","given":"Raphael"},{"family":"Mandolo","given":"Jonathan"},{"family":"Katunga-Phiri","given":"Vincent"},{"family":"Tembo","given":"Dumizulu"},{"family":"Mitole","given":"Ndaona"},{"family":"Musasa","given":"Samantha"},{"family":"Sichone","given":"Simon"},{"family":"Lakudzala","given":"Agness"},{"family":"Sibale","given":"Lusako"},{"family":"Matambo","given":"Prisca"},{"family":"Kadwala","given":"Innocent"},{"family":"Byrne","given":"Rachel L."},{"family":"Mbewe","given":"Alice"},{"family":"Henrion","given":"Marc Y. R."},{"family":"Morton","given":"Ben"},{"family":"Phiri","given":"Chimota"},{"family":"Mallewa","given":"Jane"},{"family":"Mwandumba","given":"Henry C."},{"family":"Adams","given":"Emily R."},{"family":"Gordon","given":"Stephen B."},{"family":"Jambo","given":"Kondwani C."}],"issued":{"date-parts":[["2020",8,5]]}}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}](https://www.zotero.org/), and blood donors in South Africa in January 2021 (a range from 31.8% in cities in provinces in South Africa to 62.5%).

Only 38.9% of participants experience acute flu-like symptoms since the start of the pandemic.

These indicate that infection rates could be higher in some settings, but only the latter was designed as a representative sample and serology-based estimates are sparse in SSA.

Soon after its first notified COVID-19 case (on March 6, 2020), Cameroon closed its borders and implemented significant social and physical distancing measures, including mandatory bar closures after 6 PM, limitations on public transport occupancy, bans on gatherings of more than 50. The highest seven-day moving average was seen on June 21, with 459 cases. Cases have dropped off since then, although there been a notable rise in January and February of 2021. The total number of reported cases as at February 14, 2021 only 32, 098, with 479 deaths. But due to limited PCR testing, it is likely that this figure underestimates the true burden of infection, necessitating population serosurveys.

This report presents the protocol and results of our study using a lateral-flow immunoassay to assess the seroprevalence of anti-SARS-CoV-2 IgG and IgM antibodies in a region of Yaounde, the capital of Cameroon.

# Methods

## Sampling

Based on power calculations with an assumed prevalence of 20%, a precision of 5% and a confidence level of 95% we estimated a required sample of 245 participants. The final target population was increased to 1000 people (250 households) to improve precision.

Households were randomly selected from a pre-processed set of residential buildings on an OpenStreetMap footprint[ITEM CSL\_CITATION {"citationID":"bv3UKgeS","properties":{"formattedCitation":"\\super 9\\nosupersub{}","plainCitation":"9","noteIndex":0},"citationItems":[{"id":97,"uris":["http://zotero.org/users/6990598/items/KVTM2A64"],"uri":["http://zotero.org/users/6990598/items/KVTM2A64"],"itemData":{"id":97,"type":"webpage","abstract":"OpenStreetMap is a map of the world, created by people like you and free to use under an open licence.","container-title":"OpenStreetMap","language":"en-GB","title":"OpenStreetMap","URL":"https://www.openstreetmap.org/","accessed":{"date-parts":[["2021",2,5]]}}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}](https://www.zotero.org/). In cases where non-residential buildings were encountered by the surveyors, or households were unwilling to participate, the residential building to the right of the sampled one was used as a replacement.

In each household, all individuals between 5 and 80 years were included if they: (a) were living in the selected household, (b) had been present in the household for at least 14 days, and (c) could give written informed consent (or had an adult guardian who could give consent). People with severe psychiatric illness or temporary visitors to the household were not considered for inclusion.

## Testing

Our study used the Abbott Panbio™ COVID-19 IgG/IGM Rapid Test Device, an immunochromatographic test for the qualitative detection of IgG and IgM antibodies to SARS-CoV-2. The test has a manufacturer-estimated sensitivity and specificity of 95.8% and 94% respectively.

The tests were performed on capillary blood which was collected from a finger prick from all the consenting participants. A questionnaire was also administered in tandem with the testing.

## Data analysis

Seroprevalence values were weighted within each age or sex stratum to match the age-sex distribution of the Yaounde population, as sourced from the 2018 Cameroon DHS[ITEM CSL\_CITATION {"citationID":"f7VNw5Cg","properties":{"formattedCitation":"\\super 10\\nosupersub{}","plainCitation":"10","noteIndex":0},"citationItems":[{"id":51,"uris":["http://zotero.org/users/6990598/items/AQRYHXKP"],"uri":["http://zotero.org/users/6990598/items/AQRYHXKP"],"itemData":{"id":51,"type":"report","event-place":"Yaoundé, Cameroun et Rockville, Maryland, USA","publisher":"Institut National de la Statistique/INS et ICF","publisher-place":"Yaoundé, Cameroun et Rockville, Maryland, USA","title":"Enquête Démographique et de Santé du Cameroun 2018"}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}](https://www.zotero.org/).

We used the Rogan-Gladen formula to adjust IgG seroprevalence estimates to account for test performance.[ITEM CSL\_CITATION {"citationID":"LKCAKz5h","properties":{"formattedCitation":"\\super 11\\nosupersub{}","plainCitation":"11","noteIndex":0},"citationItems":[{"id":49,"uris":["http://zotero.org/users/6990598/items/YWASLDTL"],"uri":["http://zotero.org/users/6990598/items/YWASLDTL"],"itemData":{"id":49,"type":"article-journal","container-title":"American Journal of Epidemiology","DOI":"10.1093/oxfordjournals.aje.a112510","ISSN":"1476-6256, 0002-9262","issue":"1","language":"en","page":"71-76","source":"DOI.org (Crossref)","title":"Estimating prevalence from the results of a screening test","volume":"107","author":[{"family":"Rogan","given":"Walter J."},{"family":"Gladen","given":"Beth"}],"issued":{"date-parts":[["1978",1]]}}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}](https://www.zotero.org/) sensitivity estimate provided by Batra and others’ validation study of the Abbott test, which found a sensitivity of 91.5% (75 correct diagnoses out of 82 samples) when applied on sera collected from hospitalized COVID-19 patients 14 – 56 days post symptom onset.[ITEM CSL\_CITATION {"citationID":"rTuAEd4S","properties":{"formattedCitation":"\\super 12\\nosupersub{}","plainCitation":"12","noteIndex":0},"citationItems":[{"id":53,"uris":["http://zotero.org/users/6990598/items/KS9BKRPN"],"uri":["http://zotero.org/users/6990598/items/KS9BKRPN"],"itemData":{"id":53,"type":"article-journal","container-title":"Journal of Clinical Virology","DOI":"10.1016/j.jcv.2020.104645","ISSN":"13866532","journalAbbreviation":"Journal of Clinical Virology","language":"en","page":"104645","source":"DOI.org (Crossref)","title":"A comparative evaluation between the Abbott Panbio™ COVID-19 IgG/IgM rapid test device and Abbott Architect™ SARS CoV-2 IgG assay","volume":"132","author":[{"family":"Batra","given":"Rahul"},{"family":"Olivieri","given":"Luis Gonzalez"},{"family":"Rubin","given":"Delfin"},{"family":"Vallari","given":"Ana"},{"family":"Pearce","given":"Sandra"},{"family":"Olivo","given":"Ana"},{"family":"Prostko","given":"John"},{"family":"Nebbia","given":"Gaia"},{"family":"Douthwaite","given":"Sam"},{"family":"Rodgers","given":"Mary"},{"family":"Cloherty","given":"Gavin"}],"issued":{"date-parts":[["2020",11]]}}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}](https://www.zotero.org/) We measured specificity by applying the test on a panel of 246 pre-pandemic (2017) samples from hospital patients in Yaounde. The IgG test correctly diagnosed 230 of 246 samples (93.5% specificity).

For seropositivity risk factor analysis, we used logistic models with household random effects to account for within-household clustering. In the logistic models, the following prospective risk factors were analysed: sex, age, education, BMI group, occupation, contact with an international traveller since March 1st, contact with a suspected or confirmed COVID case since March 1st, presence of comorbidities (combining hypertension, respiratory illness, diabetes, tuberculosis, HIV, cardiovascular illness and “other illnesses” which were not explicitly listed in questionnaire), whether or not the respondent is the breadwinner, adherence to social distancing rules, location of the household (one of nine health zones), number of household members, and whether or not there are children in the household. Each variable was first analysed in a univariate model. Then variables with p < 0.10 for at least one factor level were entered into the multivariable analysis. All such variables are shown in the regression tables.

## Ethical considerations

The study protocol obtained the ethical clearance and the administrative authorization of the Ministry of Health of Cameroon. Every adult participant (21 years or above) signed an informed consent. For minors, a person with parental authority was asked to sign the consent form and, if the age was equal to or above 15 years, an assent was also requested. Questionnaires were coded and names of participants were recorded in a confidential list available only to the study team. Before starting the study, all the team members were trained on research ethics, good clinical practices and study protocol and procedures.

# Results

Out of 255 household visited during the survey period, 192 (75%) agreed to participate in the study,

for a total of 1,007 respondents (figure 1). However, in 37 cases (4%), some members of the household, despite responding to the questionnaire, refused the test. However, for 37 (4%) individuals,

Of the 192 included households, 128 were the originally sampled by the random method, while the remaining 64 (33%) were replaced through standard procedures because the identified buildings were non-residential (Figure 1). All participants were to be tested for SARS-CoV2-antibodies, but

Participants reflected the age-sex distribution of the Yaounde population: Participants had a median age of 26 (IQR 14-38) years and 570 (56.6%) were women, which closely reflects the distribution of the Yaounde population (Supplementary Fig 1). The demographic characteristics of respondents are summarized in Table 2.

Of the 970 respondents tested for IgG and IgM antibodies, 340 (35.1%) were seropositive for at least one of the antibodies (Figure 1). IgM seropositivity was quite low, and the overlap between IgG and IgM seropositivity was minimal; among the 32 individuals who were IgM positive, only 6 were also IgG positive.

Figure 3 shows distribution of positive serology in the different areas of *Cité Verte* district. This distribution may be partly explained by household size. The figure makes clear that the zone with the smallest households, Cité Verte (mean size 5.5 residents), is also the zone with the lowest prevalence. Therefore, spread within the household or living environment is a driving factor for exposure to SARS-CoV-2 in the Cameroonian community.

Adjustments for diagnostic test performance slightly increased the Tables 3 and 4 show the seroprevalence adjustments for the age-sex distribution of the Yaounde population and for diagnostic test performance. Since women were oversampled as compared to their proportion in the general population (56.6% of sample was female), and women also showed a lower seroprevalence, the crude estimates were downwardly biased. Thus, population weighting increased the overall estimate of seropositivity in nearly all age categories for both the IgG and IgM assays. Adjustments for specificity and sensitivity also increased the estimates slightly.

Variables that were associated with SARS-CoV-2 seropositivity in univariable analyses included sex, educational level, BMI group, contact with an international traveler, contact with a suspected or confirmed COVID case, health zone, and number of household members (Table 5). Age, sex, and any variables where a p-value below 0.1 was observed, were carried over into the multivariate analysis. The results are shown in the last two columns of Table 5. These are largely in line with the findings from the univariate analysis.

Three hundred and two respondents (30%) reported having at least one symptom compatible with SARS-CoV-2 infection (frequency of symptoms is reported in Figure 4).

Among those who tested positive for anti-SARS-CoV-2 IgG, 40% reported at least one symptom. Among these, the most common symptoms reported were fever (18.5%), headache (17.5%), cough (17.9%) and runny/stuffy nose (12.3%), and all four were significantly more common in seropositive than in seronegative individuals (Figure 5). Surprisingly, anosmia or ageusia was only experienced by 4.3% of the seropositive respondents (versus 1.9% of seronegative respondents).

Based on the WHO criteria for COVID-suspect symptoms[ITEM CSL\_CITATION {"citationID":"UPCsVuoI","properties":{"formattedCitation":"\\super 13\\nosupersub{}","plainCitation":"13","noteIndex":0},"citationItems":[{"id":60,"uris":["http://zotero.org/users/6990598/items/QTH8Q7KA"],"uri":["http://zotero.org/users/6990598/items/QTH8Q7KA"],"itemData":{"id":60,"type":"article-journal","abstract":"11 p.","language":"fr","note":"Accepted: 2020-08-20T05:33:46Z\nnumber: WHO/2019-nCoV/SurveillanceGuidance/2020.7\npublisher: Organisation mondiale de la Santé","source":"apps.who.int","title":"Surveillance de la santé publique dans le contexte de la COVID-19 : orientations provisoires, 7 août 2020","title-short":"Surveillance de la santé publique dans le contexte de la COVID-19","URL":"https://apps.who.int/iris/handle/10665/333903","author":[{"family":"Santé","given":"Organisation","dropping-particle":"mondiale de la"}],"accessed":{"date-parts":[["2020",12,29]]},"issued":{"date-parts":[["2020"]]}}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}](https://www.zotero.org/), 51 of 328 IgG/IgM seropositive individuals (15.6%) and 64 of 642 seronegative individuals (10%) reported COVID-suspect symptoms, suggesting that the WHO criteria may lack specificity for identifying true COVID-19 symptoms—these might be common symptoms with other respiratory infections or similar pathologies.

Concerning the effect of the epidemic on the households, 163 households (85%) reported that their income had fallen since March 1st. Households where the head was a salaried worker or had a university degree appeared to be least financially affected, with only 67% and 63% reporting an income reduction (Figure 10).

# Discussion

These seropositivity estimates seen here are in line with observed values in other regions. Many countries have now conducted large seroprevalence studies in the general and specific populations, and seropositivity has ranged from as low as 3% to more than half of those studied. In the African context, a few studies have been reported. A survey in Kenya among blood donors found a global adjusted prevalence of 4.3% very early in the epidemic. Another report in Niger State, Nigeria (data not yet published) reported a prevalence of 25.4%.

Notably, there is evidence of pre-existing reaction to SARS-CoV-2 antibody testing in African populations: 23.7% (32/135) of pre-pandemic samples from a study in Gabon (a neighbouring country to Cameroon) were found to have humoral cross-reactivity to SARS-CoV-2. Thus, adjusting for test specificity, as we have done here, is crucial to arrive at accurate findings about population exposure to SARS-CoV-2

...being of male sex, being obese (as defined by a BMI >30), and having five or more household members, are the three independent factors related to anti-SARS-CoV-2 IgG seropositivity. Evidence-based interventions for epidemiological surveillance may choose to focus on these individuals...

...It is important to note that because anti-SARS-CoV-2 immunoglobulins wane over time (one study has reported a 90% decline in levels 3 months from exposure), antibody seroprevalence is not a perfect proxy for past infection with the virus. It is possible that the higher seroprevalence seen in men and the obese, and the trend observed towards higher seroprevalence at older levels, may reflect a more severe. Those with symptomatic infection (more likely to be old) are also those with the stronger antibody responses, with antibodies receding less quickly...

...the seroprevalence results here should be interpreted with some caution, since our study was not able to validate the test sensitivity on local PCR-positive sera, relying instead on a validation study from a European population....

Of the surveyed households, 11 reported a death during the period of the pandemic, of which none was reported to be known COVID-19 related. And \_\_ individuals reported hospitalization, of which only one was reported to be COVID-19 related. This would imply a hospitalization rate of < 0.3%, although this should be interpreted with caution, since self-reports of COVID-19 hospitalization may be subject to stigma avoidance bias, and the shortage of tests may mean that individuals with COVID-19 went undiagnosed.

Important doubts exist regarding the use of rapid point-of-care antibody tests in clinical settings, due to their far-from-perfect specificity values (CITE). This is valid as a worry regarding clinical use, but it less important for population-based surveys, provided that sensitivity and specificity are properly accounted for, as we have done here.

Confidence in our results is increased by the fact seropositivity showed the correlations with household size and COVID-like symptoms that would be expected.

Understanding what populations have already developed antibodies to SARS-CoV-2 is vital for public health planning. It allows to understand whether large-scale spread––additional waves of infection––are still possible. It also provides data that allows us to do a retrospective review of public health prevention measures: that is, it allows us to ask questions like: to what extent were these measures effective? And, how can hygiene measures be reinforced for future epidemics.

By studying a random sample of participants in a West African city, this study gives an idea of what levels of spread might be reasonable to expect in similar cities in Africa where serosurveys have not been done. While the estimates arrived at in this cannot serve as a stand-in for other African cities where serosurveys have not been done, similar results in other studies suggest that the extent of underreporting of cases is vast. we should expect that the high degree of underreporting may be mirrored. not be too far from what might be expected in similarly-dense African cities with like climates.

Our study shows the feasibility of doing community-based door-to-door serosurveys in cities in SSA. A number of validated SARS-CoV-2 antibody tests now exist on the market,[ITEM CSL\_CITATION {"citationID":"3zhGBr6h","properties":{"formattedCitation":"\\super 14\\nosupersub{}","plainCitation":"14","noteIndex":0},"citationItems":[{"id":42,"uris":["http://zotero.org/users/6990598/items/DK6EEX9S"],"uri":["http://zotero.org/users/6990598/items/DK6EEX9S"],"itemData":{"id":42,"type":"article-journal","abstract":"Numerous SARS-CoV-2 rapid serological tests have been developed, but their accuracy has usually been assessed using very few samples, and rigorous comparisons between these tests are scarce. In this study, we evaluated and compared 10 commercially-available SARS-CoV-2 rapid serological tests using the STARD methodology (Standards for Reporting of Diagnostic Accuracy Studies). 250 sera from 159 PCR-confirmed SARS-CoV-2 patients (collected from 0 to 32 days after onset of symptoms) were tested with rapid serological tests. Control sera (N = 254) were retrieved from pre-COVID periods from patients with other coronavirus infections (N = 11), positive rheumatoid factors (N = 3), IgG/IgM hyperglobulinemia (N = 9), malaria (n = 5), or no documented viral infection (N = 226). All samples were tested using rapid lateral flow immunoassays (LFIA) from 10 manufacturers. Only four tests achieved ≥98% specificity, with other tests ranging from 75.7%-99.2%. Sensitivities varied by the day of sample collection, from 31.7%-55.4% (Days 0-9), 65.9%-92.9% (Days 10-14), and 81.0%-95.2% (>14 days) after the onset of symptoms, respectively. Only three tests evaluated met French Health Authorities’ thresholds for SARS-CoV-2 serological tests (≥90% sensitivity + ≥98% specificity). Overall, the performances between tests varied greatly, with only a third meeting acceptable specificity and sensitivity thresholds. Knowing the analytical performance of these tests will allow clinicians and most importantly laboratorians to use them with more confidence, could help determine the general population’s immunological status, and may help to diagnose some patients with false-negative RT-PCR results.","container-title":"Journal of Clinical Microbiology","DOI":"10.1128/JCM.02342-20","ISSN":"0095-1137, 1098-660X","language":"en","note":"publisher: American Society for Microbiology Journals\nsection: Immunoassays\nPMID: 33239381","source":"jcm.asm.org","title":"Evaluating Ten Commercially-Available SARS-CoV-2 Rapid Serological Tests Using the STARD (Standards for Reporting of Diagnostic Accuracy Studies) Method.","URL":"https://jcm.asm.org/content/early/2020/11/24/JCM.02342-20","author":[{"family":"Dortet","given":"Laurent"},{"family":"Ronat","given":"Jean-Baptiste"},{"family":"Vauloup-Fellous","given":"Christelle"},{"family":"Langendorf","given":"Céline"},{"family":"Mendels","given":"David-Alexis"},{"family":"Emeraud","given":"Cécile"},{"family":"Oueslati","given":"Saoussen"},{"family":"Girlich","given":"Delphine"},{"family":"Chauvin","given":"Anthony"},{"family":"Afdjei","given":"Ali"},{"family":"Bernabeu","given":"Sandrine"},{"family":"Pape","given":"Samuel Le"},{"family":"Kallala","given":"Rim"},{"family":"Rochard","given":"Alice"},{"family":"Verstuyft","given":"Celine"},{"family":"Fortineau","given":"Nicolas"},{"family":"Roque-Afonso","given":"Anne-Marie"},{"family":"Naas","given":"Thierry"}],"accessed":{"date-parts":[["2020",12,8]]},"issued":{"date-parts":[["2020",11,25]]}}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}](https://www.zotero.org/) and some of these are which are affordable, easy to use and provide quick results. There are, however, important concerns about the specificity of these tests (CITE), so researchers should be sure to validate the tests on local PCR-positive sera before deploying widely. Used properly, these antibody tests offer the opportunity to more accurately assess the prior infection rate of populations in regions where PCR-based testing has been uncommon.



**Figure 1:** Recruitment process and study profile

**Table 1:** Sociodemographic characteristics of the participants in the final sample of 1007 study participants. N is the number of individuals in each stratum. IQR: Interquartile range. BMI: Body mass index

|  |  |  |
| --- | --- | --- |
| **Characteristic** | **N** | **%** |
| Age | Median:26 | IQR:14 - 38 |
| ***Age groups*** | | |
| 5 - 14 | 248 | 24.6 |
| 15 - 29 | 339 | 33.7 |
| 30 - 44 | 218 | 21.6 |
| 45 - 64 | 156 | 15.5 |
| 65 + | 46 | 4.6 |
| ***Sex*** | | |
| Female | 570 | 56.6 |
| Male | 437 | 43.4 |
| ***BMI*** | | |
| < 18.5 (Underweight) | 164 | 16.3 |
| 18.5 - 24.9 | 414 | 41.1 |
| 25 - 30 (Overweight) | 259 | 25.7 |
| > 30 (Obese) | 166 | 16.5 |
| Unknown | 4 | 0.4 |
| ***Education Level*** | | |
| Secondary | 442 | 43.9 |
| Primary | 328 | 32.6 |
| University | 157 | 15.6 |
| No formal instruction | 53 | 5.3 |
| Doctorate | 20 | 2 |
| Other | 7 | 0.7 |
| ***Profession*** | | |
| Student | 418 | 39.5 |
| Small trader | 222 | 21 |
| Businessperson | 131 | 12.4 |
| Home-maker | 74 | 7 |
| Unemployed | 73 | 6.9 |
| Salaried worker | 60 | 5.7 |
| Retired | 35 | 3.3 |
| Other | 46 | 4.3 |
| ***Chronic conditions*** | | |
| Hypertension | 37 | 3.6 |
| Respiratory illness | 17 | 1.7 |
| Diabetes | 11 | 1.1 |
| Other | 951 | 93.6 |



**Figure 2:** **Crude IgG and IgM seroprevalence: A.** Euler diagram showing seropositivity of respondents by antibody test. **B.** Seropositivity of respondents by antibody test and age-sex stratum. Percentage labels indicate the proportion of each stratum that is IgG and/or IgM seropositive. **C.** Household and geographic variation in seropositivity. Fill colour indicates the neighbourhood seroprevalence (IgG and/or IgM). Pie charts indicate household size, household location and the proportion of the household that is seropositive. Pie charts are dodged to avoid overlap and to preserve location anonymity. Five households are not shown due to improperly-coded or missing coordinates.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **n** | **Seropos.** | **Seroprevalence (95% confidence interval)** | | |
|  |  |  | *Crude* | *Population-weighted* | *Weighted, test-adjusted* |
| **Total** | 971 | 302 | 31.1% (28.3 - 34.1) | 31.3% (28.4 - 34.3) | 29.2% (24.3 - 34.1) |
| **Female** | 549 | 154 | 28.1% (24.5 - 32.0) | 28.0% (24.4 - 31.9) | 25.3% (20.0 - 31.2) |
| **Male** | 422 | 148 | 35.1% (30.7 - 39.7) | 34.6% (30.2 - 39.3) | 33.1% (27.6 - 40.5) |
| **5 - 14** | 241 | 69 | 28.6% (23.3 - 34.6) | 28.7% (23.3 - 34.7) | 26.1% (18.9 - 34.1) |
| **15 - 29** | 325 | 98 | 30.2% (25.4 - 35.4) | 30.7% (25.9 - 35.9) | 28.5% (21.4 - 35.1) |
| **30 - 44** | 212 | 69 | 32.5% (26.6 - 39.1) | 32.7% (26.7 - 39.3) | 30.8% (22.9 - 39.5) |
| **45 - 64** | 153 | 51 | 33.3% (26.4 - 41.1) | 34.1% (27.0 - 41.9) | 32.5% (22.8 - 41.8) |
| **65 +** | 40 | 15 | 37.5% (24.2 - 53.0) | 39.4% (25.8 - 54.8) | 38.7% (20.5 - 55.8) |

**Table 2:** Population-weighted and test-adjusted seroprevalence estimates for anti-SARS-CoV-2 IgG antibodies

**Figure 3:** **Risk factor** **analysis for IgG seropositivity among participants tested for antibodies. n = 966** OR: Odds ratio. Asterisks indicate significance at a 0.05 alpha level. 41 individuals (4%) were dropped due to variable missingness. Recent contact indicates contact since March 1st, 2020. A “COVID case“ is a confirmed *or* suspected COVID-19 case. Variables that were found to be not significant at a 0.10 alpha level, and which were not controlled for in the multivariate regression, include occupation, presence of comorbidities, breadwinner status, adherence to social distancing rules and presence of children in the household.





#### Figure 4: Acute symptoms of survey participants. Acute symptoms were any symptoms noticed by the respondent between March 1st and the date of survey, which were not related to any pre-existing health condition. A. Euler plot showing the intersection of acute and COVID-like symptoms with seropositivity (example interpretation: 50 of 302 IgG seropositive individuals had COVID-19-suspect symptoms [WHO guideline for diagnostic suspicion], and 65 of 669 IgG seronegative individuals had COVID-19 suspect symptoms). B. Most common symptom profiles among IgG seropositive individuals. C. Comparison in frequency of symptoms between IgG seropositive and seronegative individuals. 𝝌-square: \* p < 0.05

# Contributors

JL, DMP, and SIH conceived and planned the study. JL wrote the computer code, and designed and carried out the analyses with input from FMS and DMP. DJWe constructed the accessibility covariate data layer. JL produced all output figures. DJWi, DAW, NR, RRdC provided intellectual inputs into aspects of this study. All authors contributed to the interpretation of the results. JL wrote the first draft of the manuscript and all authors contributed to subsequent revisions.

# Declarations of interests

The authors declare no competing interests.

# Data sharing

The study protocol and the individual participant data can be made available...

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# Figures and Tables

# Additional Files

Appendix 1:



**Supplementary Figure 1. Timeline for sampling for SARS-CoV-2 seroprevalence.** **A.** Weekly crude IgG and IgM seroprevalence and 95% confidence interval. **B.** Daily number of samples collected from participants in each district of Cité Verte.

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