Original Research Article

Prevalence of anti-SARS-CoV-2 antibodies in sellers at two main Goma markets in the eastern Democratic Republic of Congo.

Abstract

Objective

Official data on Coronavirus Disease 19 (COVID-19) pandemic in the Democratic Republic of Congo (DRC) show a low prevalence. This study assessed the seroprevalence of antibodies against the severe acute respiratory syndrome Coronavirus 2 (SARS-CoV-2) in the two main markets of Goma city, in the eastern DRC.

Methods

We conducted a cross-sectional study to determine the seroprevalence of antibodies against SARS-CoV-2 in 454 sellers in Kituku and Virunga markets between September 1st and November 08th, 2021. Participants were asked to answer a questionnaire survey on COVID-19 symptoms and their attitudes against COVID-19, including whether they had been vaccinated against COVID-19. Presence of anti-SARS-CoV-2 in blood samples was investigated using QuickZen®.

Results

The median (minimum-maximum) age of participants was 27.4 years (13.4-88.3). Participants aged 15 to 40 years old made up 80.6 % of the participants enrolled in the study (n=454), with women accounting for 65.1 % of all participants. No participant in the study had been vaccinated against SARS-CoV-2.

The overall crude and adjusted seroprevalence rates of antibodies anti-SARS-CoV-2 were 73.8 % (95 % CI 69.7-77.9) and 82.7 % (95 % CI 79.2 % -86.2 %), respectively.

COVID-19 symptoms were absent for 43,1% (n = 332) of the participants with anti-SARS-CoV-2 antibodies. During the same period, none of the participants with anti-SARS-CoV-2 antibodies required hospitalization.

Conclusion: We discovered a high seroprevalence of anti-SARS-Cov-2 antibodies in the sellers at the two main Goma markets without any record of vaccination against SARS-CoV-2. No severe COVID-19 symptoms were reported among participants.

Keywords: Democratic Republic of Congo, antibodies, SARS-CoV-2, COVID-19, seroprevalence.

Introduction

The Coronavirus Disease 2019 (COVID-19), a pandemic that took the world by storm at the end of 2019 is a disease caused by Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2), an RNA virus beta-CoV of group 2B virus which was first described in the Hubei province of China (1).

The pandemic has impacted global health and the economy seriously. Two years into the COVID-19 pandemic and despite alarming predictions on the COVID-19 pandemic in Africa (2-4), sub-Saharan African countries have somehow withstood the burden of the disease COVID-19, as highlighted by the few severe cases and deaths reported by these African countries during the past two years.

The Democratic Republic of Congo (DRC), which reported its first COVID-19 case on March 10th, 2020, sits among the countries which have so far reported few COVID-19 cases. As of August 11th, 2022, this 90-million-people country had reported 92,554 COVID-19 cases and 1,357 deaths related to this pandemic (5).

The North Kivu province which straddles the borders of Rwanda and Uganda reported its first COVID-19 case on March 30th, 2020. As of August 11th, 2022, it has since confirmed a total of 10,790 cases with 597 deaths for a population of 10,1 million inhabitants (Epidemiological surveillance unit database, Goma, North Kivu Provincial Health Division, DRC).

These low numbers of official reported cases (both in the North-Kivu province of and the whole DRC) are intriguing, given the lack of implementation of measures to stop the spread of SARS-CoV-2 in most cities and settlements in the country. The low RT-PCR detection capacity in the country is widely acknowledged (6, 7), and fails short of the recommendations of the World Health Organization regarding SARS-CoV-2

testing at the national level (8), and thus could explain the probable underreporting of COVID-19 cases as well as deaths related to this pandemic in DRC.

One plausible hypothesis is that whereas SARS-CoV-2 might have circulated heavily in the country, most of the population probably has been able to develop efficient immunity which has protected them against severe forms of the disease, and therefore, did not feel the need to seek any medical help and therefore cannot be reported as COVID-19 cases. Furthermore, due to the paucity of surveys on the prevalence of COVID-19 in the country, it is impossible to know the real extent of the COVID-19 pandemic in the country. Indeed, the few serosurveys available in this 90-million country have been carried out in two towns: Bukavu and Kinshasa. Both studies suggested a higher seroprevalence of anti-SARS-CoV-2 antibodies in the surveyed participants (9,10).

Goma at the north edge of Kivu Lake is one of the biggest and bustling cities in DRC and an important nexus connecting Rwanda, Uganda, Kenya, Kinshasa, Bukavu, and Bujumbura as well as the DRC hinterland. Given its location and the connections, Goma is a potential hub for rapid expansion of COVID-19 within its population and beyond. This survey aimed to evaluate the seroprevalence for anti-SARS-CoV-2 antibodies in the overcrowded markets of Kituku and Virunga in this eastern Congolese city. The rationale behind this choice is that these markets represent a case for potentially high SARS-CoV-2 transmission. Indeed, these markets are congested, with thousands of people flocking there daily with high risk of SARS-CoV-2 spreading by the millions of droplets emitted (11). This study's findings will contribute to getting insight into the current state of anti-SARS-CoV-2 seroprevalence in the city of Goma.

Material and methods

Between September 1st, 2021, and November 8th, 2021, we conducted a survey for the assessment of seroprevalence of anti-SARS-CoV-2 antibodies on consenting sellers in the markets of Kituku and Virunga in the city of Goma, in DRC.

Goma, a city of around 1 million inhabitants, is located between the northern shore of kivu lake and the south of the Nyiragongo volcano, and straddles Rwanda border. It is a critical commercial hub in the eastern region of the countries and harbors several markets, of which the Virunga market (north-east of Goma) and Kituku market (west of Goma) are the main. It is estimated that number of people present at Kituku and Virunga markets at midday are around 20000 at each market, among which 4000 sellers at each market. Accordingly, these markets were sampled for detection of anti-SARS-CoV-2 antibodies. Other people are buyers who spend around two hours in the market.

During the period of the study, no vaccine was available for the general population, except for healthcare personnel. Therefore, all the subjects included in the study had not yet been vaccinated.

The sample size of the study was calculated using the sample size calculator software (12), based on the following parameters: i) a confidence level of 95%, a prevalence (population proportion) of 50%, a margin of error of 5%, and a target population of 30000. The sample was augmented by 20% to compensate for non-consenting or absent sellers on the day of sampling, which set the number of participants at 457, with a minimum of 381 participants.

A team of 7 members was dispatched (3 outreach members, 3 pollsters, and 1 laboratory worker) was dispatched in the two markers for the survey. After securing the greenlight from market heads, a systematic sampling was carried out. Systematic

sampling consisting of the sampling for one seller out of ten sellers in each row within the market.

Ethical considerations

The Université Catholique de Bukavu's Internal Review Board (UCB/CIES/NC/022/2021) reviewed and approved this study. Before enrollment, all participants provided written consent or assent. Human specimens were taken with the informed consent of all participants. Given the low level of literacy, only verbal consent was sought and obtained. This verbal consent was recorded, prior to sampling, by local first-line responders. Healthcare workers and physicians signed the following statement: “We have explained the study to the participants and are satisfied that he/she understands and consents to participate in the survey”.

In the first step, selected participants were interviewed for the presence of symptoms commonly associated with COVID-19 (13) during the past six months and for their knowledge about the disease by the means of a questionnaire. Subsequently, fresh finger-prick blood was drawn from each participant and dropped directly into the well of the QuickZen® COVID-19 IgM/IgG kit (ZenTech, Angleur, Belgium), an immune colloidal gold lateral flow test kit which detect IgM and IgG against SARS-CoV-2 S-RBD (receptor-binding domain of the S protein of SARS-CoV-2). The results were interpreted following the manufacturer's recommendations.

Statistical analyses

Statistical analyses were performed using the SPSS statistical package release 26.0 for Windows (SPSS, Inc., Chicago, IL). The crude seroprevalence was calculated a as the proportion of participants positive for anti-SARS-CoV-2 antibodies. The

adjusted seroprevalence was calculated using the formula published by Sempos and Tian (14) by integrating the characteristics of the QuickZen® assay as determined by Montesinos et al (15): Adjusted Prevalence = Crude prevalence × Positive Predictive V +(1-Crude prevalence) × (1-Negative Predictive Value). Differences in group proportions and categorical variables were assessed using the chi-square test. A *p*-value <0.05 was considered as statistically significant.

Results

A total of 454 participants were enrolled in the study. Table 1 shows the socio-demographic characteristics of participants.

Table 1: Sociodemographics characteristics of participants included in SARS-CoV-2 seroprevalence survey among sellers at two main Goma markets, Eastern DRC, 2021.

Characteristics	Percentage (Number)
Participants per market (454)	
Kituku market	47.8 (217)
Virunga market	52.2 (237)
Residential commune of participants (n = 453)	
Goma	38.2 (173)
Karisimbi	58.7 (266)
Nyiragongo	3.1 (14)
Age in years of participants (n = 454)	
< 25	31.7 (144)
25 - 39	48.9 (222)
≥ 40	19.4 (88)

Gender (n = 453)	
Male	34.9 (158)
Female	65.1 (295)
Mask donning during the survey (442)	
Donning a mask	17.6 (78)
Not donning a mask	82.4 (364)

In both markets, sellers were generally young (n = 454) [Median age in years (min – max)] [28.4 (13.8 – 88.3)]. Sellers in Kituku market (n = 217) appeared younger [median age in years (min – max)] [27.4 (15.3 – 82.3)] compared to those in Virunga market (n = 237) [30.3 (13.8–88.3)] but there was no statistically significant difference (p = 0.06). Participants under 50 years old constituted 92.7% of the participants (n = 454). Women in Kituku and Virunga market represented 52.8% (n=216) and 76.4% (n=237) of participants respectively.

Both markets were overcrowded and no social measures to mitigate the spread of SARS-CoV-2 were implemented. Only 17.6% (n = 442) of participants surveyed donned a mask correctly. The remaining participants either did not wear a mask correctly (i.e., the mask did not cover completely and simultaneously the nose and the mouth [48.4% (n = 442)] or did not have any mask at all [33.9% (n = 442)]. Among the 78 subjects who properly wore the mask, 66.2% wore a washable cloth mask while 33.8% wore a surgical mask.

Table 2: Crude SARS-CoV-2 seroprevalence according to several characteristics of sellers at two main Goma markets, Eastern DRC, 2021.

Characteristics	Crude SARS-CoV-2 seroprevalence %	OR (95% IC)	p
Market			

Virunga (n = 236)	79.2	1.17 (1.04 – 1.31)	0.006
Kituku (n = 214)	67.8	1	
Age in years			
≥ 40 (n = 87)	80.1	1,14 (0,98 – 1,32)	
25 - < 40 (n = 219)	73.1	1,03 (0,90 – 1,18)	0,26
< 25 (n = 144)	70.8	1	
Gender			
Male (n = 157)	73.9	1.00 (0.89 – 1.13)	0,95
Female (n = 292)	73.6	1	
District of residence			
Karisimbi (n = 264)	75,8	1,07 (0,95 – 1,21)	
Nyiragongo (n = 14)	71,4	1,03 (0,72 – 1,43)	0,50
Goma (n = 171)	70,8	1	
Has travelled during the past 12 months			
Yes (n = 132)	78,8	1,10 (0,98 – 1,23)	0,12
No (n = 318)	71,7	1	
History of contact with declared Covid-19 patients			
Yes (n = 61)	88,5	1,24 (1,11 – 1,38)	0,005
No (n = 389)	71,5	1	
History of clinical symptoms suggesting Covid-19			
Yes (n = 211)	89,6	1,50 (1,34 – 1,68)	< 0,001
No (n = 239)	59,8	1	

The overall crude and adjusted seroprevalence of anti-SARS-CoV-2 antibodies were 73.3% (95% CI: 69.7% - 77.9%) and 82.7% (95% CI: 79.2% - 86.2%) respectively. Participants (n = 450) with IgM anti-SARS-CoV-2 antibodies only, IgG only, or IgM and IgG anti-SARS-CoV-2 antibodies simultaneously were detected in 9.1%, 41.8 %, and 22.9% participants respectively.

Respectively, 16.3% (n = 332) and 5.9% (n = 118) among subjects who tested positive for anti-SARS-CoV-2 antibodies and those who did not, had contact with a suspected Covid-19 subject. Considering only subjects who tested positive for anti-SARS-CoV-2 antibodies and had contact with a suspected Covid-19 subject, this contact was either a distant family member [32.7% (n = 52)], a friend [30.8% (n = 52)], or a close family member [21.2% (n = 52)]. The location of this contact with a suspected Covid-19 subject for those who tested positive for anti-SARS-CoV-2 antibodies was either at home [46.0% (n = 50)], a funeral ceremony [24.0% (n = 50)], the workplace [1 6.0% (n = 50)], or a joyful ceremony [12.0% (n = 50)].

Table 2 provides data on seroprevalence of anti-SARS-CoV-2 antibodies during the survey with respect to several parameters. The prevalence of anti-SARS-CoV-2 antibodies was higher in the Virunga market compared to Kituku market ($p = 0.006$).

The seroprevalence of anti-SARS-CoV-2 antibodies tended to increase with seller age, but the difference was not statistically significant (chi square for linear trend p = 0,13).

Among sellers with anti-SARS-CoV-2 antibodies, 43.1% (n=332) replied that they had never felt any symptoms among those defined as suggestive of an infection with SARS-CoV-2.

During the same period, none of the participants with anti-SARS-CoV-2 antibodies required hospitalization.

Discussion

We performed a survey on the seroprevalence of anti-SARS-CoV-2 antibodies in sellers of Kituku and Virunga, the two major markets of Goma city in eastern DRC from September 1st to November 8th, 2021.

Our results reveal a whopping seroprevalence rate above 70% among participants, with the rate among sellers in the Virunga market slightly higher than in the Kituku market. We have no explanation for this difference between the two markets, although the fact the Virunga market is in an area with informal overcrowded settlements and having the most contacts with East African countries in comparison to the Kituku one. Age class or sex did not impact on anti-SARS-CoV-2 seroprevalence. Indeed, Goma markets are overcrowded with people not observing social measures against the propagation of COVID-19, as highlighted by the very low proportion of sellers (17.6%) donning a mask correctly. This is compounded by the fact that Goma sellers are constantly advertising their goods by shouting, which results in the emission of millions of droplets and hence creates optimal conditions for transmission of SARS-CoV-2 (11).

The absence of severe cases among people with seroprevalence of anti-SARS-CoV-2 antibodies could be because our study population was young. In our sample, only six subjects were over 65 years old. Severe Covid-19 cases are more common in subjects over 60 years old (16,17). Besides, the limited number of subjects over 65 years old could explain the lack of association between seroprevalence of anti-SARS-CoV-2 antibodies and age.

Seroprevalence rates from our survey are among the highest recorded ever in a non-vaccinated population. Although these rates cannot be extrapolated to the whole city of Goma, they nevertheless indicate a high level of transmission of SARS-CoV-2 in the whole city. Goma inhabitants have no choice but to attend markets daily to buy essential stuff like food because they cannot simply stockpile food (due to a lack of a guaranteed income and the absence of conservation infrastructure, notably the electricity shortage which renders any use of refrigerators almost impossible for most inhabitants). In this context, the high level of seroprevalence among sellers could have a potential impact on SARS-CoV-2 transmission to Goma inhabitants.

Therefore, the likelihood of getting contaminated by SARS-CoV-2 when in the market is very high. Back home, they can act as new potential spreaders of the SARS-CoV-2 in their households and their neighborhoods.

The few available studies in DRC have consistently shown a high anti-SARS-CoV-2 seroprevalence. In a study in Kinshasa at the end of the first wave showed a seroprevalence of antibodies against SARS-CoV-2 of 16.6% in this metropolis (10). Recently, a serosurvey in Bukavu city (DRC) revealed a very high level of anti-SARS-CoV-2 seroprevalence in a slum of the city of Bukavu city in DRC [Irenge et al, Seroprevalence of anti-SARS-CoV-2 antibodies in a densely populated district of the city of Bukavu in the Democratic Republic of Congo (unpublished study)]. Other serosurveys performed on healthcare personnel of the Panzi hospital in Bukavu (DRC) revealed an anti-SARS-CoV-2 seroprevalence rate of 41.2% (9).

Another major finding of our study is the absence of severe COVID-19 cases among participants despite the high circulation of the SARS-CoV-2 virus among them, as

demonstrated the very high prevalence of anti-SARS-CoV-2. This finding is consistent with observations on morbidity and mortality of COVID-19 in Sub Saharan African countries and has been extensively discussed in other papers (18). To complete our study, lysis tests may be necessary on serums with antibodies against SARS-CoV-2 to verify if they are protective, thus justifying the low level of severity requiring consultation with health services so that the declaration of Covid-19 can be done correctly onsite in the country.

Our study had several limitations. Firstly, whereas the seroprevalence has been adjusted to the sensitivity and specificity of our qualitative assay, it still does not allow to have an insight of population's immunological state. Indeed, a positive result with insufficient antibodies may not protect against SARS-CoV-2 re-infection. However though limited by the short history of Covid 19 infection, a recent study in USA demonstrated a sustained positivity rate of antibodies against the SARS-CoV-2 spike protein ten months post-PCR confirmed COVID-19 infection (19).

Secondly, we did not perform any test to clearly confirm the high SARS-CoV-2 large circulation especially it has been noted cross-reaction between human coronaviruses (20) including seasonal coronaviruses.

The third limitation arises from the fact that we surveyed a group that does not reflect the real composition of households in Goma. Indeed, children, working-class and elderly people are not among the people likely to be sellers in the market. In addition, women are overrepresented among sellers in these markets and accordingly in they were also overrepresented among participants in the survey. Therefore, maximum caution is required in interpreting the results of the study. Accordingly, extrapolation of seroprevalence rates in sellers from the two markets to the whole population of Goma should not be condoned.

Despite these limitations, the results of our survey confirm that SARS-CoV-2 is transmitted highly in Goma markets and probably in the whole city and way beyond. The high transmission in these markets should not come as a surprise, given the sheer lack of social measures against COVID-19 propagation. This has allowed the virus to roam free and contaminate people at will. Like the scarce data on COVID-19 in DRC, point to the fact that official estimates of COVID-19 seroprevalence in the DRC are probably way below the true figures in DRC. This perplexing situation in the DRC may be caused by a significant underestimation of the total number of cases due to the country's limited testing capacity (6, 7). Also, this low detection capacity is a direct consequence of centralization-based governance, with teams in Kinshasa determined to hold grip of financial and technical levers in all fields, including healthcare and outbreaks management. This results in a low detection capacity, delays in reporting, and in implementation of efficient policies aimed at monitoring and controlling the COVID-19 pandemic in the country. Our results warrant studies in other DRC cities, as well as in the countryside to a real insight into the real extent of the COVID-19 pandemic.

Conclusion

Our study found a high seroprevalence of anti-SARS-CoV-2 antibodies among sellers in the markets of Goma city in DRC without any record of vaccination against SARS-CoV-2, without participants reporting severe symptoms. It can be implied from our findings that the official policy to fight COVID-19 in the country cannot be showcased as a success given the high prevalence.

The low fatalities cases recorded in the country are probably the consequences of the characteristics of the population (acquired immunity, youth age) rather than the

success of policies put in place by healthcare officials in Kinshasa to combat the pandemic COVID-19.

Disclaimer

The findings and conclusions in this study are those of the authors and do not necessarily represent the official position of their respective institutions.

Ethics approval statement

This protocol study was reviewed and approved by the Ethical Review Committee of the "Université Catholique de Bukavu" (number UCB/CIES/NC/02312021). All participants or their guardians (in the case of children) provided written consent before enrollment.

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