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SARS-CoV-2 antibody seroprevalence and associated risk factors in an urban district in Cameroon

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Abstract

The extent of SARS-CoV-2 circulation in many African countries remains unclear, underlining the need for antibody sero-surveys to assess the cumulative attack rate. Here, we present the results of a cross-sectional sero-survey of a random sample of residents of a health district in Yaoundé, Cameroon, conducted from October 14 to November 26, 2020. Among the 971 participants, the test-adjusted seroprevalence of anti-SARS-CoV-2 IgG antibodies was 29·2% (95%CI 24·3–34·1). This is about 323 times greater than the 0.09% nationwide attack rate implied by COVID-19 case counts at the time. Men, obese individuals and those living in large households were significantly more likely to be seropositive, and the majority (64·2% [58·7–69·4]) of seropositive individuals reported no symptoms. Despite the high seroprevalence, most of the population had not been infected with SARS-CoV-2, highlighting the importance of continued measures to control viral spread and quick vaccine deployment to protect the vulnerable.

Introduction

The 2019 coronavirus disease (COVID-19) has placed an unprecedented burden on health systems around the world. In resource-limited settings within sub-Saharan Africa (SSA), gaps in medical infrastructure, difficulties in implementing hygiene measures, and perceived public health vulnerabilities were projected to lead to overwhelming morbidity and mortality burdens.[1,2]

To date, however, official counts of COVID-19 cases and deaths suggest a relatively mild epidemic trajectory on the African continent. As of March 4, 2021, only two African countries, Egypt and South Africa, had reported more than 9 000 COVID-19 related deaths.[3] Cameroon, which reported its first case on March 6, 2020, had reported only 35 714 cases one year after, implying an attack rate of 1·43 cases per thousand residents (as compared with the 50·7 cases per thousand 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 much of the continent, timely and effective preventive measures put in place by governments, the young and predominantly rural population, and cross-reactive immunity from other infections as potential mitigating factors.[2,4] However, the true scale of the epidemic in many African countries is still unclear, as the PCR and antigen-confirmed case counts that are commonly relied on may understate viral spread.[2,5]

In this context, the use of serological antibody tests to detect past exposure to the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is valuable. Serological assays can detect evidence of SARS-CoV-2 infection from two weeks to several months after the onset of symptoms, and can reveal past infection even in asymptomatic cases.[6,7] They are therefore valuable for accurately assessing the cumulative attack rate—the proportion of the population that has ever been infected with SARS-CoV-2.

However, only a few SARS-CoV-2 antibody serosurveys have been conducted in African countries to date,[8,9,10,11,12,13] and the majority of sero-surveys have been conducted on healthcare workers, convenience samples of blood donors and other non-representative populations; no published surveys have been performed on a random sample of the general population in an African country. Here, we report the results of a cross-sectional, community-based sero-survey of

a random sample of residents in a health district of Yaoundé, the capital city of Cameroon. We aimed to estimate the prevalence of anti-SARS-CoV-2 antibodies in this population, to assess risk factors for seropositivity, and to investigate the symptoms of seropositive respondents.

Results

Out of the 255 households visited between October 14 and November 26, 2020, 180 (70·6%) agreed to participate, resulting in a final sample of 971 participants (full study profile in appendix 1 p 1). Table 1 shows the sociodemographic characteristics of the final sample. The median age of participants was 26 years (IQR: 14–38), and 56·5% of them were female (n = 549). The majority were students (39·3%, n = 402), informal workers (21·3%, n = 218) or traders (12·6%, n = 129). A total of 112 respondents (11·5%) reported suffering from a chronic condition, mainly hypertension (3·3%, n = 32), respiratory illnesses (1·7%, n = 17) or diabetes (1·1%, n = 11).

Of the 971 respondents tested for antibodies, 302 (31·1%) were IgG positive, 32 (3·3%) were IgM positive, and a combined 328 (35·1%) were positive for at least one antibody type (figure 1A). The overlap between IgG and IgM seropositivity was low, with only six individuals testing positive for both antibody types. Active COVID-19 infection was uncommon: only one PCR test was positive among the 21 tests performed on suspected cases, for an implied active infection rate of 0·1%.

The highest overall seroprevalence (IgG and/or IgM) was seen in the Briqueterie neighbourhood, where 43·8% (95% CI 30·7–57·7) of tested residents were seropositive (figure 1C). All neighbourhood-level seroprevalence estimates are reported in appendix 1 (p 3). Most households (73%, 131 of 180) had at least one seropositive resident but the range of household-level seroprevalence was broad: from 0 to 100%, with a median of 33% (IQR ± 25%). Notably, there were only two households (1·1%) in which everyone was seropositive; one of these was a single-resident household and the other had two residents. The detailed distribution of household seropositivity is reported in appendix 1 (p 4).

After population weighting and test performance adjustment, the overall seroprevalence of IgG antibodies was 29·2% (95% CI 24·3–34·1; table 2). Men had a higher seroprevalence than women (33·1% [27·6–40·5] versus 25.3% [20·0–31·2]), and seroprevalence increased with age, although

these differences were not statistically significant. The proportion of IgM-positive individuals was lower (3·3%) than the expected false positive rate of the IgM test (6·9%), so adjusted IgM seroprevalence estimates were statistically indistinguishable from zero. For this reason, IgM results were not considered in the analysis of symptoms or of seropositivity risk factors.

The multivariable risk factor analysis for IgG seropositivity revealed significantly higher odds of seropositivity for men (OR: 1·61 [95%CI 1·2–2·2]), residents of households with six or more residents (OR: 1·6 [1·1–2·4]; reference: households with three to five residents) and individuals with a BMI above 30 kg/m² (OR: 1·84 [1·1–3·0]; reference: 18·5–24.9 kg/m²). The highest stratified seroprevalence was seen in respondents who had been in contact with a known or suspected COVID-19 case: 45·7% (16 of 35) of these individuals were IgG positive.

Among the 302 IgG seropositive participants, 35·8% (n = 108) reported having had at least one COVID-19-related symptom; among the 669 IgG seronegative participants, this proportion was 28·0% (n = 187) (figure 3a). The most common symptoms reported among the IgG seropositive individuals were fever (18·5%, n = 56), headache (17·6%, n = 53), cough (17·9%, n = 54) and rhinorrhoea (12·3%, n = 37), and all four were significantly more common in seropositive than in seronegative individuals (figure 3c). Surprisingly, anosmia and/or ageusia was only experienced by 4·3% (n = 13) of the seropositive respondents. Cough alone and cough plus rhinorrhoea were the two most common symptom profiles among IgG seropositive participants (figure 3b). In terms of severity, 80% of IgG seropositive respondents with symptoms (83 of 104) graded these symptoms as mild or moderate.

Among the 302 IgG seropositive individuals, only 27 (8·9%) consulted any healthcare services over the pandemic period (appendix 1 p 5). The most common medications taken by this group were paracetamol (19·9%, n = 60), traditional medicines (14·6%, n = 44) and antibiotics (10·3%, n = 31; appendix 1 p 6), and these were most commonly self or family-prescribed.

A total of 46 respondents reported having been hospitalised between March 1, 2020 and the date of survey, but only one of these was reported to be COVID-19-related, implying a hospitalization rate of 0·3% (one out of 302 IgG seropositive respondents). Over the same period, 11 of the 180 surveyed households reported the death of a family member, but none of these deaths was reported to be COVID-19-linked.

Discussion

In this urban setting of Cameroon, the adjusted seroprevalence of SARS-CoV-2 IgG antibodies was found to be 29·2%, implying that around 126 000 of the district's 432 858 inhabitants had been infected with SARS-CoV-2 by the survey's end date, November 26, 2020. This proportion is about 323 times greater than the 0.09% nationwide attack rate implied by PCR and antigen-confirmed case counts at that time.[3] The large discrepancy suggests that the true cumulative incidence of COVID-19 in Cameroon may be far larger than the number of cases officially reported.

The underreporting of COVID-19 cases implied by our survey is not unique. In a recent systematic review, Chen et al. (2021) compared the number of infections estimated by seroprevalence surveys to the number of PCR-confirmed infections in a range of countries and found a pooled ratio of 11·1 (95% CI 8·3–14·9),[19] meaning that for each virologically-confirmed COVID-19 case, there were at least ten undetected infections in the community. Across individual settings, this ratio varied widely, from 2·0 in a Faroe Islands study,[20] to 103·0 in a study of Indian villages.[21] Taken together, these findings and ours suggest that PCR-confirmed case counts are poor proxies for the true attack rate of SARS-CoV-2, and that cross-national comparisons based on such case counts may be misleading.

We found that men and obese individuals (BMI > 30 kg/m²) were significantly more likely to be seropositive, and we also observed higher seropositivity, although non-significant, among older age groups. It is uncertain whether the raised seroprevalence in these groups represents a greater risk of SARS-CoV-2 infection per se, or a greater probability of antibody detection. Older, male and obese individuals are known to experience more severe COVID-19 symptoms,[22] and severe illness is linked to stronger and longer-lasting antibody responses.[23] As a result, serosurveys performed several months after infection may detect antibodies more frequently in these groups because they experienced more severe illness and stronger antibody responses, not because they were infected at higher rates.

Alternatively, the physiological factors that predispose men, the obese and the elderly to more severe disease may also make them more susceptible to initial infection. Some studies have suggested that adults may be more likely to be infected with SARS-CoV-2 than young children,[24,25]

160 and a few point prevalence studies have found slightly raised viral attack rates in men.[26,27] If the
161 risk factors for infection and those for severe illness overlap, then surveillance and prevention
162 measures that focus on the higher-risk groups may be particularly appropriate, especially in
163 contexts where stringent population-wide measures are not feasible.

164 The rate of asymptomatic infection in our study is higher than usually described; approximately
165 70% of the IgG positive individuals in the sample did not report any COVID-19-related symptoms.
166 In a recent meta-analysis by Byambasuren et al.,[28] the measured asymptomatic rate was much
167 lower—a pooled estimate of 17% (95%CI 14%–20%). COVID-19-related hospitalisation was also
168 relatively uncommon in our sample (0·3% among the IgG seropositive individuals), and no
169 COVID-19-linked deaths were reported in any of the surveyed households.

170 These favourable outcomes could reflect the relatively young population in the region of study. As
171 COVID-19 severity increases exponentially with age, the overall burden of disease in young
172 populations is expected to be less severe.[22] Cameroon's median age of 18·6 years, and the African
173 median of 19·7,[29] are therefore noteworthy, and may explain the limited COVID-19 mortality
174 impact here as compared with the other regions; the median age in Europe, for example, is 40·2
175 years.[29]

176 However, caution should be exercised in interpreting the low hospitalisation and death rates
177 implied by our study. The surveyed households reported a total of 46 hospitalisations and 11 family
178 member deaths over the pandemic period. While only one hospitalisation and none of the deaths
179 were known to be COVID-19-related, it is possible that the factors limiting testing in the general
180 population also applied to those who were hospitalised and dying. Thus, we cannot rule out the
181 possibility that some of these hospitalisations or deaths were actually COVID-19-linked. Of note,
182 a study of deceased patients in a hospital morgue in Lusaka, Zambia found that 15% of those who
183 died between June and September 2020 had COVID-19 at the time of death, although only 9% of
184 these deceased individuals were tested for SARS-CoV-2 before death.[30] Further investigations are
185 therefore required to assess the number of undiagnosed COVID-19-related deaths in countries
186 within the SSA region.

187 Our study has several major strengths. This is one of the first studies to assess SARS-CoV-2
188 antibody seroprevalence in a random sample of residents in an African city. Our random selection
189 procedure ensures representativeness of the target population and minimizes the risk of bias. The

190 study also demonstrates the feasibility of performing a geo-sampled door-to-door serological
191 survey in an African city—a simple, effective study design that can be applied widely. Finally, we
192 validated the performance of the chosen antibody test on local pre-pandemic sera, thus ruling out
193 concerns about low test specificity in African populations.[31]

194 The study was also subject to a number of limitations. We registered a household refusal rate of
195 24%, which may be a source of bias if household refusal was correlated with seropositivity.
196 Secondly, we asked participants to recall symptoms experienced over a period of seven to eight
197 months, a possible source of recall bias. This long time interval also means that we were unable to
198 directly link reported symptoms to COVID-19 infection: many of the reported symptoms may have
199 been caused by other illnesses experienced over the same time period. Lastly, we were unable to
200 validate the sensitivity of the antibody tests on local samples of known COVID-19 cases, relying
201 instead on a validation study from a European population.

202 In conclusion, our sero-survey indicates that nearly one in three individuals in Yaoundé, Cameroon
203 was exposed to SARS-CoV-2 by November 26, 2020. Together with similarly high seroprevalence
204 estimates from other SSA studies—24·5% in Niger state, Nigeria,[8] 25·1% in Abidjan, Ivory
205 Coast,[13] 19·7% in Brazzaville, Congo,[32] among others—these findings point to extensive and
206 under-reported circulation of SARS-CoV-2 in settings across the African continent. As men, obese
207 individuals, and those living in large households were found to be significantly more affected, it
208 may be valuable to tailor public health interventions toward these groups. Despite the high
209 seroprevalence, the data indicate that in Yaoundé, as in most other surveyed regions in Africa, the
210 majority of the population has so far avoided SARS-CoV-2 infection, highlighting the importance
211 of continued mitigation measures, tracing and testing, and quick vaccine deployment to curb
212 further spread.

Figures and Tables

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 groups (years)		
5 - 14	241	24.8
15 - 29	325	33.5
30 - 44	212	21.8
45 - 64	153	15.8
65 +	40	4.1
Sex		
Female	549	56.5
Male	422	43.5
BMI (kg/m²)		
< 18.5 (Underweight)	160	16.5
18.5 - 24.9	400	41.2
25 - 30 (Overweight)	247	25.4
> 30 (Obese)	160	16.5
Unknown	4	0.4
Education Level		
Secondary	433	44.6
Primary	318	32.7
University	145	14.9
No formal instruction	52	5.4
Doctorate	17	1.8
Other	6	0.6
Profession		
Student	402	39.3
Informal worker	218	21.3
Trader	129	12.6
Home-maker	74	7.2
Unemployed	70	6.8
Salaried worker	54	5.3
Retired	32	3.1
Other	43	4.2
Chronic conditions		
Hypertension	32	3.3
Respiratory illness	17	1.7
Diabetes	11	1.1
Other	52	5.3

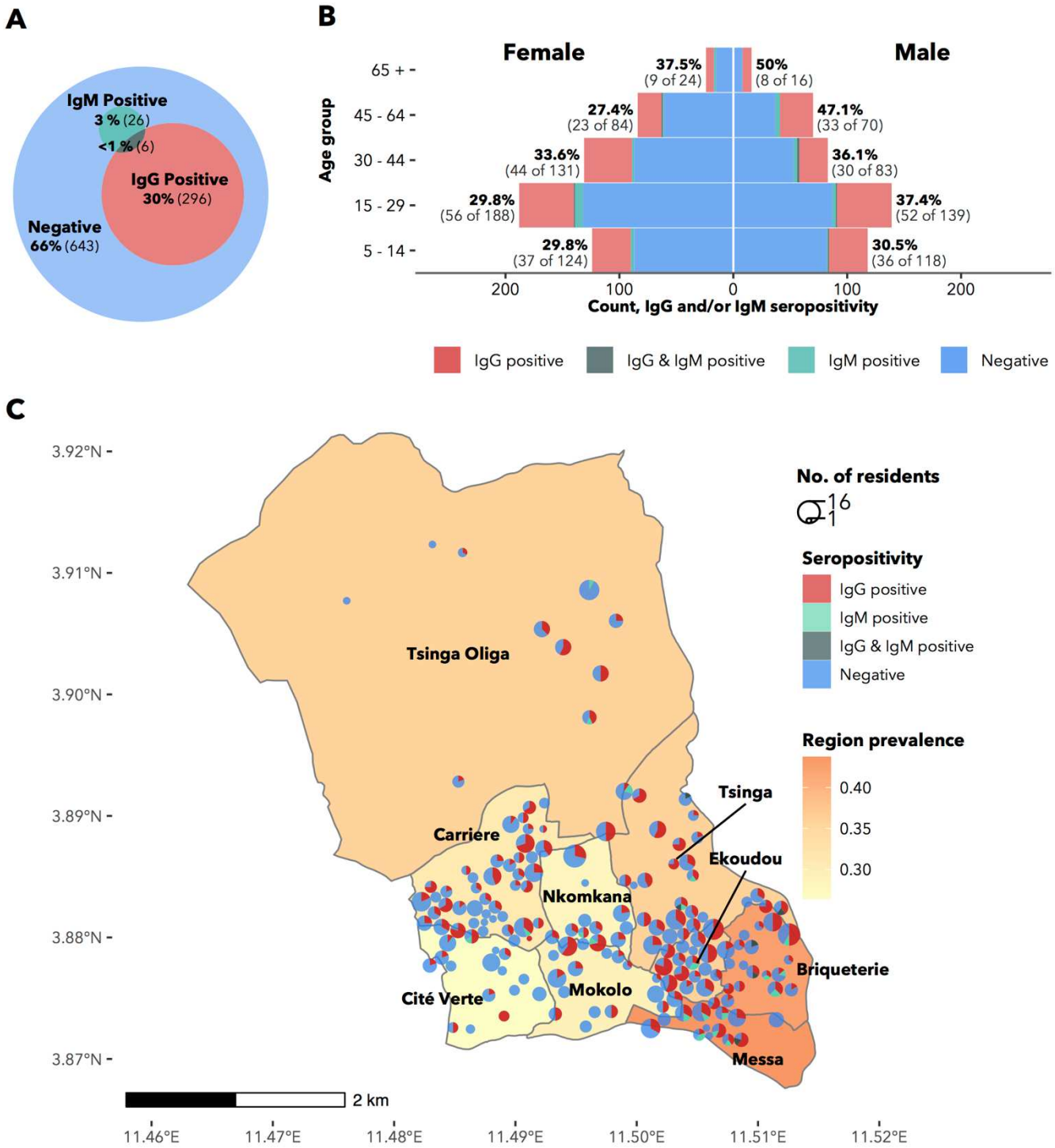

Figure 1: Crude IgG and IgM seroprevalence: A. Euler diagram showing seropositivity of respondents by antibody test. **B.** Seropositivity of respondents by antibody test and age-sex stratum. Percentage labels indicate the proportion of each stratum that is IgG and/or IgM seropositive. **C.** Household 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 and jittered to avoid overlap and to preserve location anonymity. Five households are not shown due to improperly-coded or missing coordinates.

Table 2: Age-sex weighted and test-adjusted seroprevalence estimates for anti-SARS-CoV-2 IgG antibodies. When a variable was stratified it was removed from the weights. Confidence intervals for test-adjusted estimates are Lang-Reiczigel intervals, which take into account the sample size of the antibody test validation study. Other confidence intervals are Wilson score intervals.

	n	**Pos.**	**Seroprevalence (95% confidence interval)**		
			Crude	*Population-weighted*	*Population-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)

	n	Pos.	% Pos.	Univariate OR (95% CI)	Univariate OR plot	Multivariate OR (95% CI)	Multivariate OR plot
Sex							
Female	545	153	28.1	*Reference*		*Reference*	
Male	421	148	35.2	1.4 (1.1 - 1.9)	*	1.61 (1.19 - 2.2)	*
Age							
5 - 14	239	69	28.9	0.87 (0.57 - 1.3)		0.98 (0.56 - 1.7)	
15 - 29	324	98	30.2	0.89 (0.6 - 1.3)		1.07 (0.7 - 1.6)	
30 - 44	211	68	32.2	*Reference*		*Reference*	
45 - 64	152	51	33.6	1.05 (0.66 - 1.7)		0.96 (0.59 - 1.6)	
65 +	40	15	37.5	1.33 (0.63 - 2.8)		1.28 (0.6 - 2.7)	
BMI group							
< 18.5 (Underweight)	160	45	28.1	0.97 (0.63 - 1.5)		0.91 (0.53 - 1.6)	
18.5 - 24.9	400	115	28.7	*Reference*		*Reference*	
25 - 30 (Overweight)	246	81	32.9	1.2 (0.84 - 1.7)		1.27 (0.86 - 1.9)	
> 30 (Obese)	160	60	37.5	1.53 (1.02 - 2.3)	*	1.84 (1.14 - 3)	*
Contact with international traveler							
No contact with traveler	803	245	30.5	*Reference*		*Reference*	
Recent contact with traveler	103	30	29.1	0.91 (0.56 - 1.5)		0.82 (0.49 - 1.4)	
Unsure about traveler contact	60	26	43.3	1.82 (1.02 - 3.2)	*	1.77 (0.95 - 3.3)	
Contact with COVID case							
No COVID contact	701	202	28.8	*Reference*		*Reference*	
Recent COVID contact	35	16	45.7	2.2 (1.1 - 4.6)	*	2.14 (0.99 - 4.6)	
Unsure about COVID contact	230	83	36.1	1.4 (1 - 2)	*	1.33 (0.93 - 1.9)	
Health zone							
Cité Verte	72	16	22.2	*Reference*		*Reference*	
Nkomkana	74	18	24.3	1.1 (0.48 - 2.7)		0.98 (0.4 - 2.4)	
Mokolo	94	26	27.7	1.4 (0.6 - 3.1)		1.11 (0.47 - 2.6)	
Carriere	236	72	30.5	1.6 (0.78 - 3.2)		1.51 (0.73 - 3.1)	
Tsinga Oliga	66	22	33.3	1.8 (0.77 - 4.4)		1.7 (0.69 - 4.2)	
Ekoudou	190	65	34.2	1.8 (0.89 - 3.8)		1.68 (0.8 - 3.5)	
Tsinga	81	28	34.6	1.9 (0.85 - 4.4)		1.82 (0.78 - 4.2)	
Briqueterie	106	37	34.9	1.9 (0.89 - 4.2)		1.68 (0.75 - 3.7)	
Messa	47	17	36.2	2.1 (0.82 - 5.3)		2.16 (0.82 - 5.7)	
Number of household members							
1 - 2	20	2	10	0.29 (0.06 - 1.4)		0.31 (0.06 - 1.5)	
3 - 5	238	64	26.9	*Reference*		*Reference*	
> 5	708	235	33.2	1.39 (0.96 - 2)		1.59 (1.07 - 2.4)	*

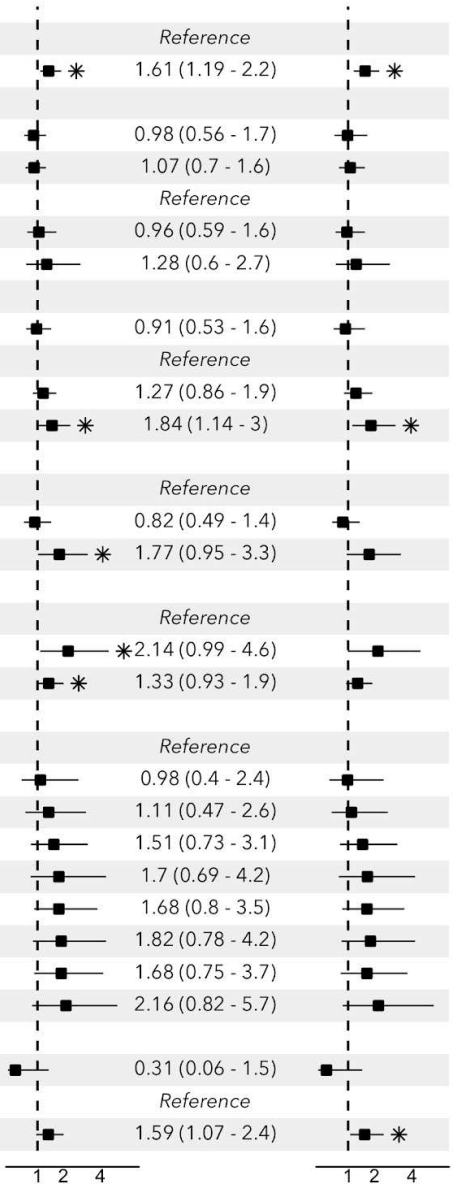

Figure 2: Risk factor analysis for IgG seropositivity n = 966. Based on logistic models with household random intercepts. Asterisks indicate significance at a 0.05 alpha level. OR: Odds ratio. 41 individuals (4%) were dropped due to missing covariables. Recent contact indicates contact since March 1st, 2020. A "COVID case" is a confirmed or suspected COVID-19 case. Variables that were found to be not significant at a 0.30 alpha level, and which were not controlled for in the multivariable regression, include presence of comorbidities, breadwinner status, adherence to social distancing rules, household neighbourhood and presence of children in the household.

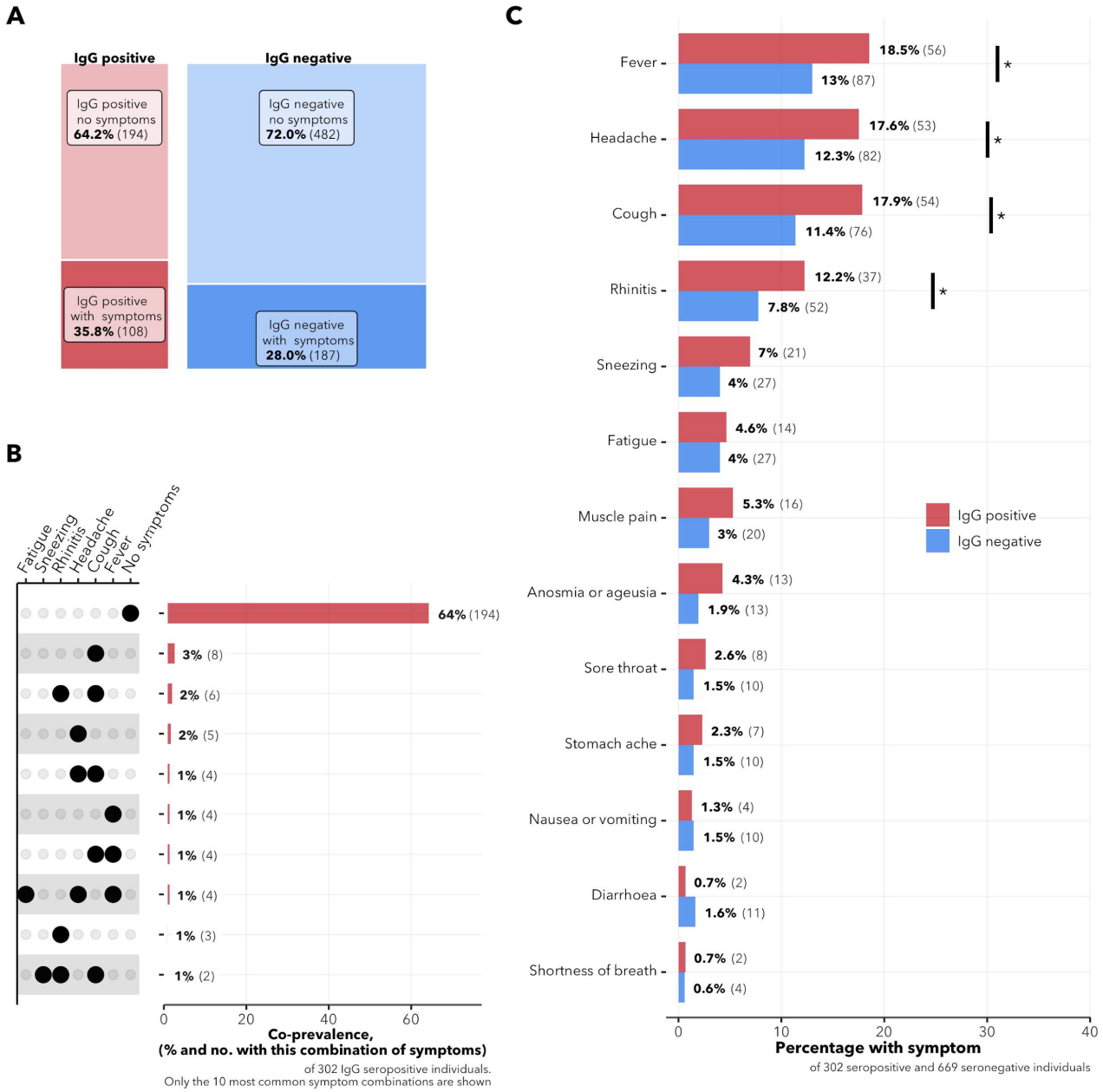

Figure 3: COVID-compatible symptoms of survey participants. Participants reported any COVID-compatible acute symptoms (all shown in panel C), which were experienced between March 1, 2020 and the date of survey. **A.** Matrix plot showing the intersection of symptomaticity with IgG seropositivity. The area of each rectangle is proportional to the number of respondents in the category. **B.** The ten most common symptom profiles among IgG seropositive individuals. **C.** Comparison in frequency of symptoms between IgG seropositive and seronegative individuals. χ- square: * $p < 0.05$

Methods

Population and sampling

The study was conducted in Cité Verte, a health district of Yaoundé, Cameroon with an estimated population of 432 858 inhabitants.

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 further increase statistical power.

Households were randomly selected from a pre-processed set of residential buildings based on OpenStreetMap data (full procedure in appendix 1 p 7).[14] Data collection took place between October 14 and November 26, 2020 (sampling timeline in appendix 1 p 2). In the field, each sampled household was visited by study investigators, who either interviewed residents on the first meeting, or arranged an appointment for a future interview if household members were not all present.

In each household, all individuals between five and 80 years of age were included if they (a) had been present in the household for at least 14 days prior to the survey, and (b) could give written informed consent (or had an adult guardian who could give consent).

Testing procedure

The Abbott Panbio™ COVID-19 IgG/IgM Rapid Test Device was used to screen for SARS-CoV-2 IgG and IgM antibodies in capillary blood collected from a finger prick. This is an immunochromatographic, lateral flow test for the qualitative detection of IgG and IgM antibodies to the nucleocapsid (N) protein of SARS-CoV-2. Test results were classified into one of five categories: negative, IgG positive alone (indicating past infection), IgM positive alone (indicating recent infection), IgG and IgM positive (also indicating recent infection), or invalid/inconclusive. Invalid/inconclusive results were repeated and classified accordingly.

The test has a manufacturer-estimated sensitivity and specificity of 95·8% and 94% respectively. However, since test specificity varies across populations, externally-assessed specificity values

may be misleading. Thus, we also validated the test specificity on a panel of 246 pre-pandemic (2017) samples from individuals living in Yaounde. The IgG test correctly diagnosed 230 of these samples (93·5% specificity), while the IgM test correctly diagnosed 229 samples (93·1% specificity). For IgG sensitivity, an estimate of 91·5% was used, as obtained from a validation study on hospitalized COVID-19 patients 14–56 days post symptom onset.[15]

Alongside serological testing, a questionnaire was administered on disease symptoms experienced since March 1, 2020, and on health-seeking behaviour over the same pandemic period.

Data analysis

To arrive at final seroprevalence estimates, crude proportions were re-weighted to match the age-sex distribution of the Yaounde population, as sourced from the 2018 Cameroon DHS.[16] We used the Rogan-Gladen formula to adjust IgG seroprevalence estimates to account for test performance,[17] and we used Lang-Reiczigel intervals for confidence intervals around these estimates.[18] We did not apply test performance corrections to the IgM seroprevalence estimates due to the inherently uncertain sensitivity of IgM tests; as IgM antibodies decline rapidly after infection, sensitivity varies widely with time since infection.

For the seropositivity risk factor analysis, we used logistic regression models with household random intercepts to account for within-household clustering. The following risk factors were analysed: sex, age (categorised as 5–14, 15–29, 30–44, 45–64 or 65+ years), highest education level (no formal instruction, primary, secondary, university, doctorate), BMI group (< 18·5, 18·5–24·9, 25–30 or > 30 kg/m²), contact with an international traveller since March 1, 2020 (recent contact, no contact or unsure about contact), contact with a suspected or confirmed COVID-19 case since March 1, 2020 (recent contact, no contact or unsure about contact), presence of comorbidities (combining hypertension, respiratory illness, diabetes, tuberculosis, HIV, cardiovascular illness and/or "other illnesses" which were not explicitly listed in the questionnaire), whether or not the respondent was the breadwinner, adherence to social distancing rules ("Yes", "No", or "Partly"), location of the household (one of nine neighbourhoods), number of household members, and whether or not there were children in the household. Each variable was first analysed in a univariate model. A Wald chi-square test was then carried out on each univariate model, and all variables below a relaxed p-value cut-off of 0·30 were entered into the

299 multivariable analysis. This full multivariate model was presented. Individuals with missing
300 covariables were not included in the regression analysis.

301 Data were processed and analysed using R version 4·0·2.

302 Ethical considerations

303 The study protocol obtained the ethical clearance (N°2020/09/1292/CE/CNERSH/SP) and the
304 administrative authorization of the Ministry of Health of Cameroon (N°D30-
305 845/L/MINSANTE/SG/DROS). Every adult participant (21 years or above) signed an informed
306 consent form and, for minors, a person with parental authority was asked to sign the consent form.
307 Minors who were able to sign were also asked to sign a special assent form. In cases where active
308 COVID-19 was suspected (based on the result of the IgG antibody test and self-reported
309 symptoms), a nasopharyngeal swab test was offered to the respondent and sent for analysis at the
310 study reference laboratory, the Chantal BIYA International Reference Centre (CIRCB) in
311 Yaoundé. All members of the survey team were trained in health research ethics and good clinical
312 practice.

313 Role of the funding source

314 The sponsors of the study had no role in study design, data collection, data analysis, data
315 interpretation, or writing of the report.

Data availability

The anonymized participant data can be shared with investigators upon signing of a data access agreement. Requests should be addressed to the corresponding author.

Code availability

The code used to generate all tabular, graphical and other analytic outputs in the paper is available at the following repository: https://github.com/kendavidn/yaounde_serocovpop_shared

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Author contributions

LC, FW and EC conceived and designed the study. FW, LM, AT and JM participated in data collection. NR designed the spatial sampling methodology. KN and EO analysed and interpreted

the data and produced the output figures. KN and JF wrote the initial manuscript, and all authors contributed to subsequent revisions and approved the final version submitted for publication. LC, EM and FW had full access to all the data in the study and KN and LC had final responsibility for the decision to submit for publication.

Declarations of interests

The authors declare no competing interests.

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Figures

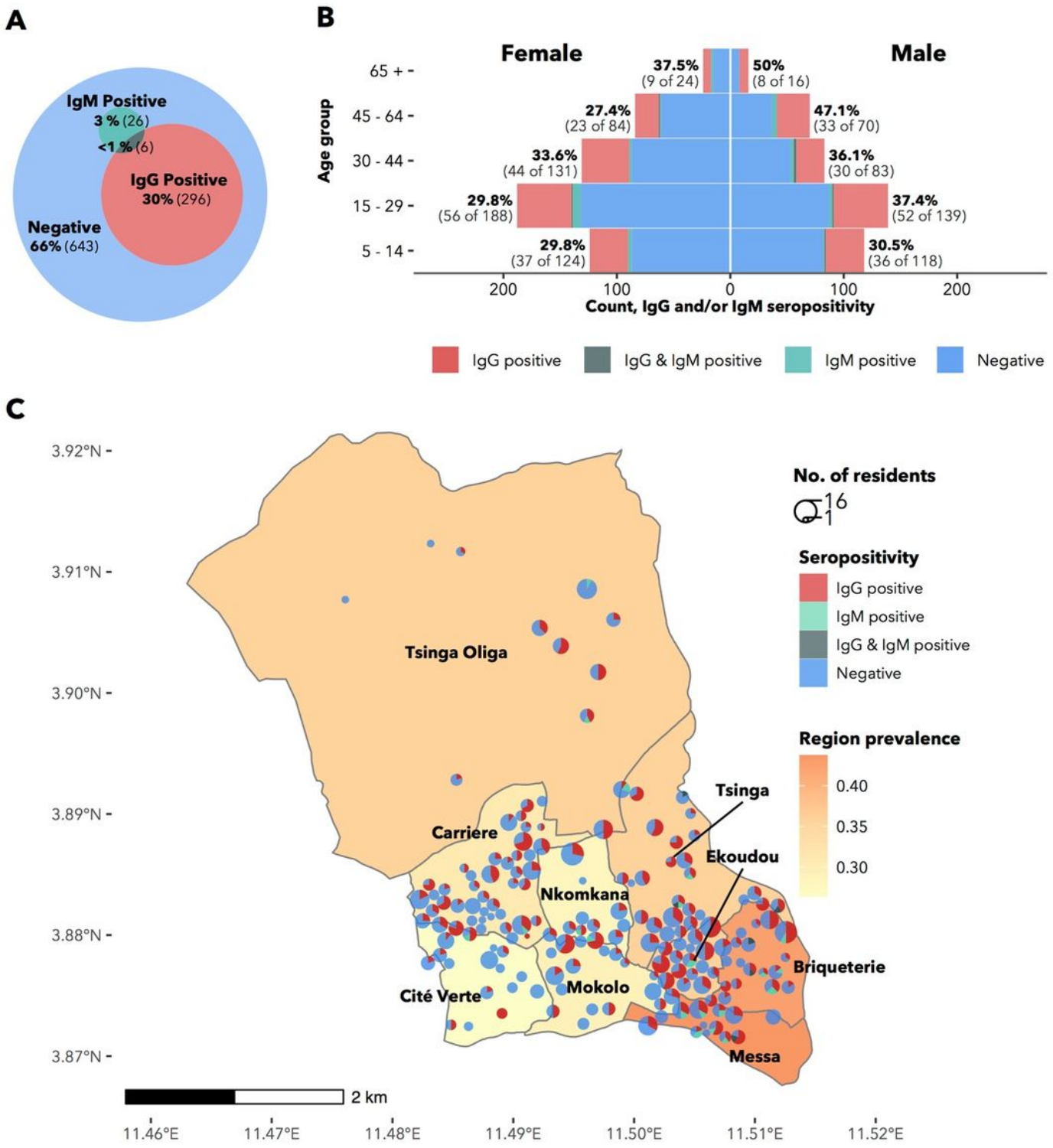

Figure 1

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 and jittered to avoid overlap and to preserve location anonymity. Five households are not shown due to improperly-coded or missing coordinates.

	n	Pos.	% Pos.	Univariate OR (95% CI)	Univariate OR plot	Multivariate OR (95% CI)	Multivariate OR plot
Sex							
Female	545	153	28.1	*Reference*		*Reference*	
Male	421	148	35.2	1.4 (1.1 - 1.9)		1.61 (1.19 - 2.2)	
Age							
5 - 14	239	69	28.9	0.87 (0.57 - 1.3)		0.98 (0.56 - 1.7)	
15 - 29	324	98	30.2	0.89 (0.6 - 1.3)		1.07 (0.7 - 1.6)	
30 - 44	211	68	32.2	*Reference*		*Reference*	
45 - 64	152	51	33.6	1.05 (0.66 - 1.7)		0.96 (0.59 - 1.6)	
65 +	40	15	37.5	1.33 (0.63 - 2.8)		1.28 (0.6 - 2.7)	
BMI group							
< 18.5 (Underweight)	160	45	28.1	0.97 (0.63 - 1.5)		0.91 (0.53 - 1.6)	
18.5 - 24.9	400	115	28.7	*Reference*		*Reference*	
25 - 30 (Overweight)	246	81	32.9	1.2 (0.84 - 1.7)		1.27 (0.86 - 1.9)	
> 30 (Obese)	160	60	37.5	1.53 (1.02 - 2.3)		1.84 (1.14 - 3)	
Contact with international traveler							
No contact with traveler	803	245	30.5	*Reference*		*Reference*	
Recent contact with traveler	103	30	29.1	0.91 (0.56 - 1.5)		0.82 (0.49 - 1.4)	
Unsure about traveler contact	60	26	43.3	1.82 (1.02 - 3.2)		1.77 (0.95 - 3.3)	
Contact with COVID case							
No COVID contact	701	202	28.8	*Reference*		*Reference*	
Recent COVID contact	35	16	45.7	2.2 (1.1 - 4.6)		2.14 (0.99 - 4.6)	
Unsure about COVID contact	230	83	36.1	1.4 (1 - 2)		1.33 (0.93 - 1.9)	
Health zone							
Cité Verte	72	16	22.2	*Reference*		*Reference*	
Nkomkana	74	18	24.3	1.1 (0.48 - 2.7)		0.98 (0.4 - 2.4)	
Mokolo	94	26	27.7	1.4 (0.6 - 3.1)		1.11 (0.47 - 2.6)	
Carriere	236	72	30.5	1.6 (0.78 - 3.2)		1.51 (0.73 - 3.1)	
Tsinga Oliga	66	22	33.3	1.8 (0.77 - 4.4)		1.7 (0.69 - 4.2)	
Ekoudou	190	65	34.2	1.8 (0.89 - 3.8)		1.68 (0.8 - 3.5)	
Tsinga	81	28	34.6	1.9 (0.85 - 4.4)		1.82 (0.78 - 4.2)	
Briqueterie	106	37	34.9	1.9 (0.89 - 4.2)		1.68 (0.75 - 3.7)	
Messa	47	17	36.2	2.1 (0.82 - 5.3)		2.16 (0.82 - 5.7)	
Number of household members							
1 - 2	20	2	10	0.29 (0.06 - 1.4)		0.31 (0.06 - 1.5)	
3 - 5	238	64	26.9	*Reference*		*Reference*	
> 5	708	235	33.2	1.39 (0.96 - 2)		1.59 (1.07 - 2.4)	

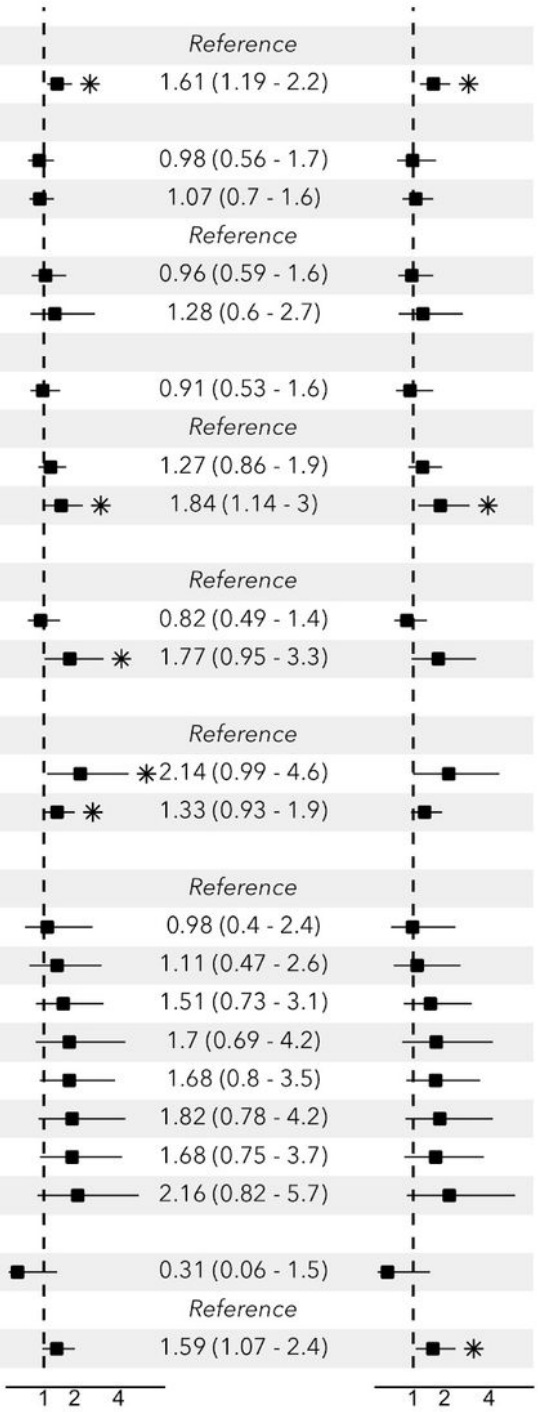

Figure 2

Risk factor analysis for IgG seropositivity n = 966. Based on logistic models with household random intercepts. Asterisks indicate significance at a 0.05 alpha level. OR: Odds ratio. 41 individuals (4%) were dropped due to missing covariables. 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 0.30 alpha level, and which were not controlled for in the multivariable regression, include presence of comorbidities, breadwinner status, adherence to social distancing rules, household neighbourhood and presence of children in the household.

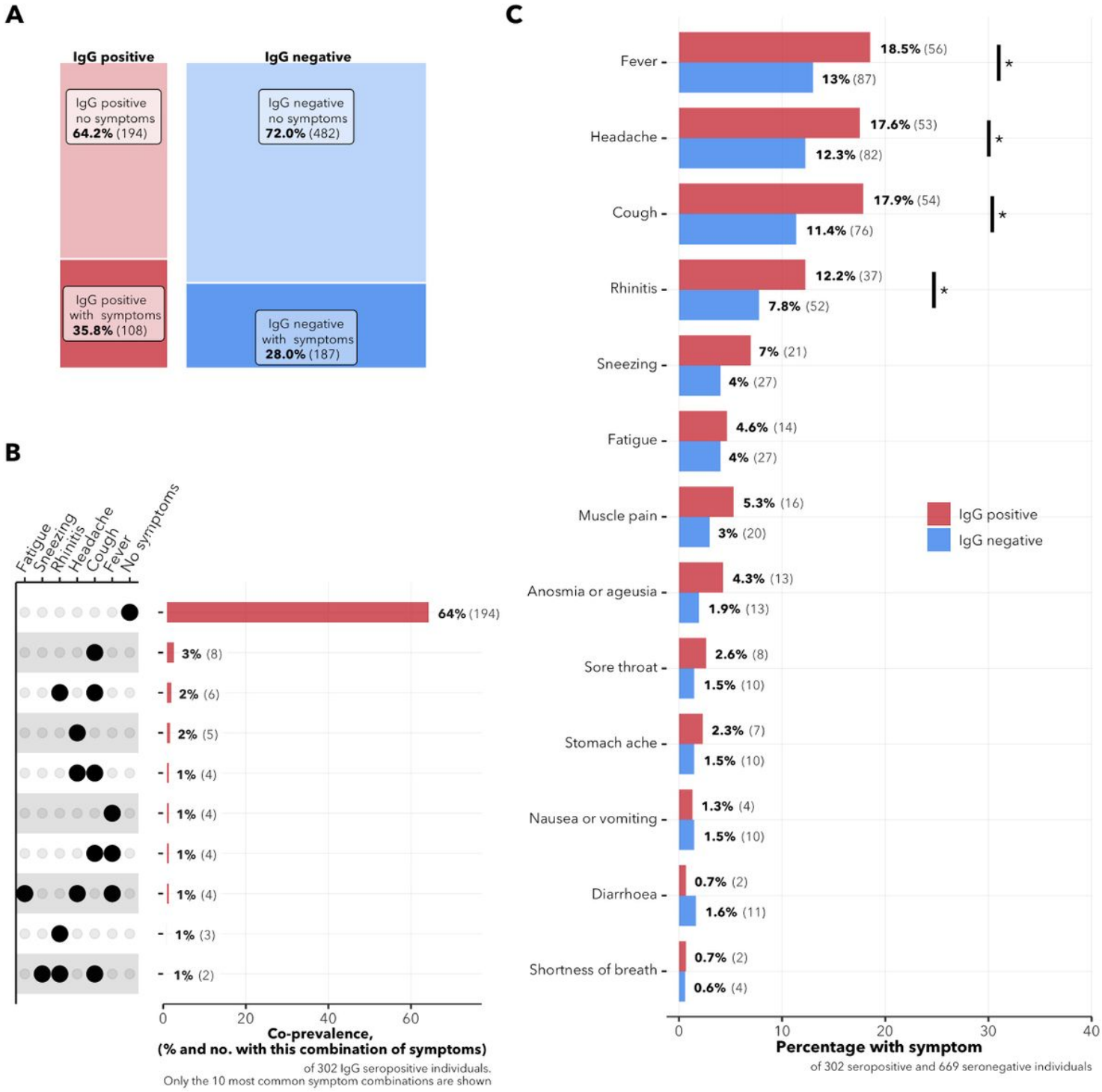

Figure 3

COVID-compatible symptoms of survey participants. Participants reported any COVID-compatible acute symptoms (all shown in panel C), which were experienced between March 1, 2020 and the date of survey. A. Matrix plot showing the intersection of symptomaticity with IgG seropositivity. The area of each rectangle is proportional to the number of respondents in the category. B. The ten most common symptom profiles among IgG seropositive individuals. C. Comparison in frequency of symptoms between IgG seropositive and seronegative individuals. χ^2- square: * $p < 0.05$

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Appendix1.pdf