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Supplementary appendix

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Supplement to: Hallal PC, Hartwig FP, Horta BL, et al. SARS-CoV-2 antibody prevalence in Brazil: results from two successive nationwide serological household surveys. *Lancet Glob Health* 2020; published online Sept 23. http://dx.doi.org/10.1016/S2214-109X(20)30387-9.

Remarkable variability in SARS-CoV-2 antibodies across Brazilian regions: report on two successive nationwide serological household surveys

SUPPLEMENTARY MATERIALS

Antibody test

Prevalence of antibodies was assessed with a rapid point-of-care test, the WONDFO SARS-CoV-2 Antibody Test (Wondfo Biotech Co., Guangzhou, China), using finger prick blood samples. This test detects immunoglobulins of both IgG and IgM isotypes specific to SARS-CoV-2 in a lateral flow assay. Two drops of blood from a pinprick are sufficient to detect the presence of antibody. The assay reagent consists of colloidal gold particles coated with recombinant SARS-CoV-2 receptor binding domain (RBD; personal communication from the manufacturer). Following the introduction of the blood sample, reactive antibody:antigen:colloidal gold complexes, if present, are captured by antibodies against human IgM and IgG present on the "test" (T) line in the kit's window, leading to the appearance of a dark-colored line. Samples without SARS-CoV-2-reactive antibodies will not lead to appearance of this line. Valid tests are identified by a positive control line (C) in the same window. If this control line is not visible, the test is deemed non-conclusive, which is uncommon. There were only 33 non-conclusive results in the over 50,000 tests carried out in the two phases.

The rapid test underwent independent validation studies. According to the manufacturer, it has a sensitivity of 86.4% and specificity of 99.6% (https://en.wondfo.com.cn/product/wondfo-sars-cov-2-antibody-test-lateral-flow-method-2/). The tests were acquired by Brazilian Ministry of Health for population surveys and surveillance programs. A validation study carried out by the National Institute for Quality Control in Health (INCQS, Oswaldo Cruz Foundation, RJ, Brazil) showed a sensitivity of 100% and specificity of 98.7%. In an evaluation of 10 different lateral flow assays, Whitman and colleagues[1] found that the Wondfo test among the two with the best performances, with sensitivity of 81.5% and specificity of 99.1%. Our own evaluation in Brazil found a sensitivity of 77.1% and specificity of 98.0%.[2] By pooling the results from the four validation studies, weighted by sample sizes, sensitivity is estimated at 84.8% (95% CI 81.4%;87.8%) and specificity at 99.0% (95% CI 97.8%;99.7%).[2]

In early April 2020, our team conducted a household probability survey in nine cities in the state of Rio Grande do Sul,[3] when the pandemic was at a very early stage in the state. Of a total sample of 4,188 subjects there were only two positive results. We believe that this survey provides a better estimate of the test's false-positive rate in the field, given that the other four studies relied on frozen samples for specificity estimation. Assuming that all cases in that survey were false positives leads to a specificity rate of 99.95%. Importantly, this conservative estimate of the specificity is higher than the estimate obtained in validation studies, further supporting that specificity in the field is higher. Whitman and colleagues, in their analyses of 10 lateral flow tests, observed "*moderate-to-strong positive bands in several pre-COVID-19 blood donor specimens, some of them positive by multiple assays, suggesting the possibility of non-specific binding of plasma proteins, non-specific antibodies, or cross-reactivity with other viruses*."[1] Our findings suggest the possibility that studies using frozen serum samples may have yielded higher false-

positive rates than those associated with testing finger prick blood. We therefore used as correction parameters in the main analyses a sensitivity of 84.8% and the 99.95% specificity derived from our previous population-based survey.[3] Analyses using the same sensitivity level and a specificity of 99.0% (the specificity obtained by pooling the four validation studies) are also presented below.

Calculation of wealth quintiles

Wealth was measured in this study through an asset index based on 8 asset variables. Internet at home and cable TV were yes/no questions, computer/notebook, TV, air conditioner and car were recorded as a number from zero to four or more and number of rooms and bathrooms in the house were recorded from zero to five or more. The eight variables were used in two sets of principal components analyses, one in each survey wage. The first component accounted for 39.2% of the total variability in the first survey phase and 39.0% in the second phase. The eigenvalues were equal to 3.1 in both phases.

The scores for the first component were extracted to be used as an asset score representing wealth in the sample. The lower the score, the poorer the family and vice-versa. Mean scores by state are shown in the Figure (for the first survey phase). We see that Roraima and Pará are the states with lowest mean scores, while Santa Catarina and Rio Grande do Sul are the richest in terms of mean asset index scores.

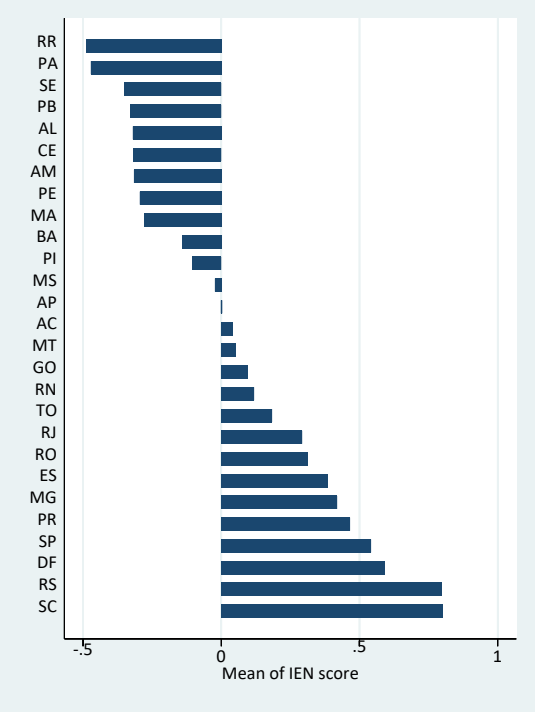

Figure. Mean asset scores (Índice Econômico Nacional: IEN) by federative units in Brazil.

The scores were divided into five groups, quintiles, each including one fifth of the sample, weighted by their sampling probability. The weights were calculated by dividing the population of each city (National Institute of Geography and Statistics projection for 2019) by the number of interviews completed in the city. This is necessary to account for the large differences in population in the cities, resulting in more representative wealth groups at national level.

The table below shows that the asset index was strongly associated with schooling of the head of the family.

Table. Distribution of schooling in the sample according to the quintiles of the asset score.

	Quintiles of the asset score					Total
Schooling	1	2	3	4	5	
1-4 years	1,594	1,020	751	548	366	4,279
5-8 years	1,388	1,035	978	745	552	4,698
9-11 years	1,555	1,702	1,887	1,966	1,646	8,756
Higher education	186	408	764	1,254	2,222	4,834
Total	4,723	4,165	4,380	4,513	4,786	22,567

Pearson chi-square (12 df) = 4100, p < 0.0001

Statistical analyses

As mentioned in the main text, the survey data was analyzed using two strategies. The first consists of accounting for the sampling design of the survey, but not for the test validity. The goal of this strategy is to provide the actual test results. In the second strategy, we accounted for both the sampling design of the survey and corrected for the test validity. The goal is to attempt to obtain estimates closer to the actual infection prevalence. Performing both strategies allows comparing results between them, such that consistency between strategies indicates that conclusions do not strongly depend on a given correction strategy. All analyses were performed using R version 3.6.1.[4]

To account for the sampling design, all survey data analyses were performed using the functionality provided by the "survey" package.[5,6] Because municipalities were selected *a priori* and census tracts were sampled within each municipality, census tracts were treated as principal sampling units and municipalities as strata. Importantly, the fact that census tracts were sampled with probability proportionate to size and a fixed number of households was sampled in each tract, this is a self-weighted design. No weighting for population size (or any other type of weighting) was performed. Variance was estimated analytically using Taylor series linearization estimation (this procedure is described in detail elsewhere[5]).

For the second strategy, estimates of test validity are required. By pooling multiple validation studies (as described above), sensitivity was estimated to be $\hat{s} = \frac{446}{526}$ and specificity was estimated to be $\hat{e} = \frac{513}{518}$.[2] However, as discussed above, the specificity is likely higher than this. Indeed, based on the first population-based survey we carried out in the state of Rio Grande do Sul in Brazil,[3] a lower bound for the specificity is $\hat{e} = \frac{2}{4151}$. Therefore, unless explicitly stated otherwise, we used $\hat{s} = \frac{446}{526}$ and $\hat{e} = \frac{2}{4151}$ as the estimates of the test validity.

We obtained corrected prevalence estimates ($\hat{\theta}$) using a maximum likelihood procedure based on the following model (the rationale for this model is described elsewhere[7]):

$$P\left(\text{observe } r \text{ positives out of } n \text{ tests} \middle| \hat{\delta}\right) = \binom{n}{r}\left(\hat{s}\hat{\theta} + (1-\hat{e})\left(1-\hat{\theta}\right)\right)^{r}\left(1-\hat{s}\hat{\theta} - (1-\hat{e})\left(1-\hat{\theta}\right)\right)^{n-r},$$

where $\hat{\delta}$ is the estimated apparent (i.e., uncorrected) prevalence.

Given $\hat{\delta}$ (obtained from the survey), $\hat{s}$ and $\hat{e}$ (obtained from the validation study), $\hat{\theta}$ was calculated as the value of $\vartheta_j \in \{0\%, 0.1\%, 0.2\%, \ldots, 100\%\}$ that maximizes the likelihood based on the model above. Assuming the likelihood is unimodal, the algorithm can be implemented by first sorting the vector ϑ in ascending distance from $\hat{\delta}$, and then check if testing additional ϑ_j values result in larger likelihood values. In our analysis, this continues until the algorithm fails to identify a value that increases the maximum likelihood (among all ϑ_j values already evaluated) for 10 consecutive attempts.

To incorporate both the uncertainty of $\hat{s}$ and $\hat{e}$ and the sampling design in the confidence interval for $\hat{\theta}$, we used the following strategy:

a) Design-adjusted standard errors for the unadjusted prevalence (denoted as $\sigma_{\hat{\delta}}$) were calculated by first fitting an intercept-only logistic regression model having the test result as the dependent variable. We then used this model to estimate $\sigma_{\hat{\delta}}$ using the "predict" function.

b) Calculate the effective sample size (N^*) – i.e., the sample size that a study using simple random sampling would be expected to have so that the standard error of $\hat{\delta}$ equals $\sigma_{\hat{\delta}}$. This was calculated as $N^* = \min\left[N, \frac{\hat{\delta}(1-\hat{\delta})}{\sigma^2_{\hat{\delta}}}\right]$, where N is the actual sample size. N^* was rounded to the nearest integer.

c) Generate the empirical sampling distribution of δ as $\hat{\delta}_r \sim \frac{B(N^*,\hat{\delta})}{N^*}$. Importantly, by using N^* instead of N in this step, the variance of the empirical sampling distribution is $\sigma^2_{\hat{\delta}}$, thus accounting for the sampling design.

d) Assuming that $\hat{s} \sim \frac{B(N_s,s)}{N_s}$ and $\hat{e} \sim \frac{B(N_e,e)}{N_e}$ (where $N_s = 526$ and $N_e = 4151$ denote the sample sizes used to estimate sensitivity and specificity, respectively), the empirical sampling distribution of these parameters can be obtained as $\hat{s}_r \sim \frac{B(N_s,\hat{s})}{N_s}$ e $\hat{e}_r \sim \frac{B(N_e,\hat{e})}{N_e}$, where $r \in \{1, \dots, R\}$.

e) For each r, calculate the corresponding value of $\hat{\theta}$ (denoted by $\hat{\theta}_r$) by replacing $\hat{s}$, $\hat{e}$ and $\hat{\delta}$ with $\hat{s}_r$, $\hat{e}_r$ and $\hat{\delta}_r$ in the maximum likelihood estimation procedure described above. The collection of all R values of $\hat{\theta}_r$ is the empirical sampling distribution of θ estimated using parametric bootstrap.

f) Estimate the standard error of $\hat{\theta}$ (denoted as $\sigma_{\hat{\theta}}$) as the standard deviation of the empirical distribution of θ.

g) Update the effective sample size (N') as follows: $N' = \min\left[N^*, \frac{\hat{\theta}(1-\hat{\theta})}{\sigma^2_{\hat{\theta}}}\right]$, rounded to the nearest integer.

h) Calculate the effective number of positive tests as $n'_p = \hat{\delta}N'$.

i) Use n'_p and N' to calculate the exact binomial confidence interval. When n'_p is not an integer, we opted by not rounding it because, due to the small number of positive tests, any rounding would correspond to a substantial relative change in the prevalence. To overcome this issue, we calculated to confidence intervals: one for the nearest smaller integer (i.e., $\lfloor n'_p \rfloor$) and another for the nearest larger integer (i.e., $\lceil n'_p \rceil$). Let a_1 and b_1 respectively denote the lower and upper limits of the confidence interval using $\lfloor n'_p \rfloor$, and a_2 and b_2 denote the same for $\lceil n'_p \rceil$. The confidence interval for n'_p was then calculated as follows: $a = \sum_{k=1}^{2} a_k w_k$ and $b = \sum_{k=1}^{2} b_k w_k$, where w_k is the weight that each confidence interval receives, calculated as follows: $w_1 = 1 - \left(n'_p - \lfloor n'_p \rfloor\right)$ and $w_2 = \left(n'_p - \lfloor n'_p \rfloor\right)$.

For hypothesis testing under strategy 2, we compared the corrected prevalence estimates (in logit scale) among groups using Cochran's Q heterogeneity, implemented as fixed effects meta-regression using the "metafor" package.[8] For this, standard errors of $\text{logit}(\hat{\theta})$ (denoted as $\sigma_{logit(\hat{\theta})}$)

were approximated as $\sigma_{logit(\hat{\theta})} = \frac{logit(b) - logit(a)}{2Q(0.975)}$ where $Q(.)$ is the quantile function for the Normal distribution.

In the following situations, the approach outlined in a)-i) above had to be slightly adapted:

- Uncorrected prevalence of 0%: in this situation, we calculated confidence intervals using the exact binomial method assuming simple random sampling. For hypothesis testing, groups in this situation were excluded from the comparisons.
- Uncorrected prevalence >0%, but corrected prevalence of 0%: in this situation, $l = 0\%$ and u was calculated as the $\left(1 - \frac{\alpha}{2}\right)100\%$ percentile of the empirical sampling distribution of θ for a $(1 - \alpha)100\%$ confidence interval. We opted by the percentile method instead of the exact binomial method in this situation to allow for the uncertainty in $\hat{\theta}$ to be incorporated in the confidence interval. For hypothesis testing, groups in this situation were excluded from the comparisons.

References

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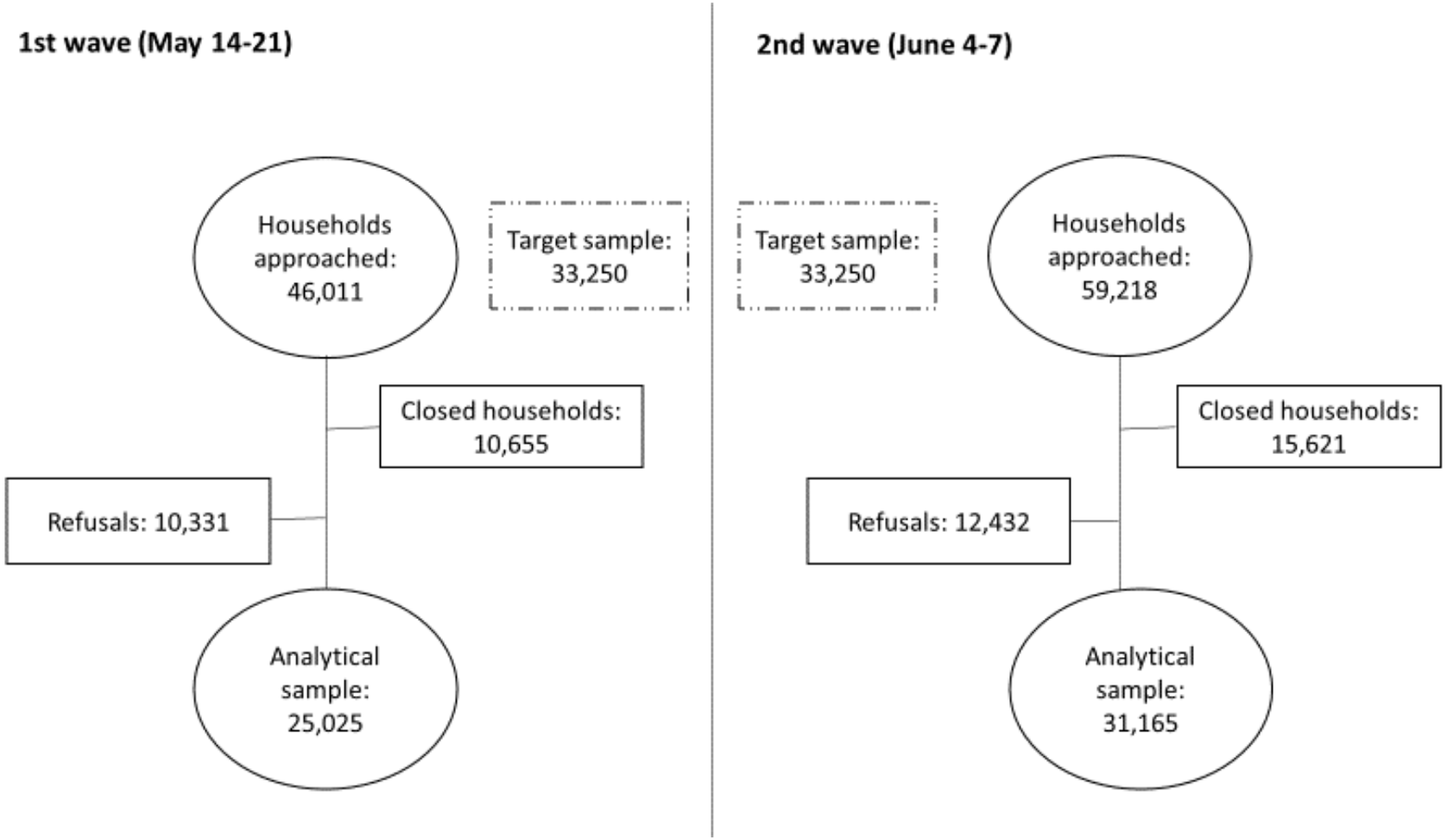
Supplementary Figure 1. Sample selection flowchart for the two phases of the study.



Supplementary Table 1. Characteristics of the 83 municipalities with 200 or more tests in both phases, other municipalities included in the study and the remaining Brazilian municipalities. Reported cases and deaths refer to cumulative numbers up to May 23.

Groups of municipalities		Population	Reported COVID-19 cases*	Reported COVID-19 deaths*	Human Development Index	Number
200-250 subjects tested in both phases	Mean	668,007	213	9.5	0.733	83
	SD	1,586,591	297	16.8	0.064	
<200 subjects tested in either phase	Mean	384,239	130	5.2	0.738	50
	SD	451,395	152	7.6	0.049	
Not included in the study	Mean	24,918	67	2.8	0.657	5,437
	SD	55,686	152	7.4	0.071	
Total	Mean	37,726	70	2.9	0.659	5,570
	SD	221,458	157	7.7	0.072	

(*) Source: https://covid.saude.gov.br/

There are 5,565 municipalities in Brazil. We compared population sizes, reported COVID-19 cases and deaths and the Human Development Index[4] in three groups of cities: the 83 where it was possible to conduct 200 or more tests during both survey waves, the remaining 50 cities included in the original sample, and the other 5,432 cities in the country (Supplementary Table 1). Cities with 200 or more tests tended to have larger populations and higher rates of reported cases and deaths than those with fewer than 200 tests, or the remaining cities in the country. The Human Development Index of the first two groups tended to be higher than in the third group of cities. Data on the index were obtained from:

PNUD. Atlas do Desenvolvimento Humano no Brasil. Brasilia: Programa das Nacoes Unidas para o Desenvolvimento; 2010.

Supplementary Table 2. Sample distribution according to sociodemographic characteristics.

	First phase		Second phase		BRAZIL 2019
	Number	%	Number	%	%
Region					
Northeast	6552	26.2%	9782	31.4%	27.2%
North	5064	20.3%	5445	17.5%	8.8%
Central-West	2477	9.9%	3562	11.4%	7.8%
Southeast	5833	23.3%	7774	25.0%	42.1%
South	5069	20.3%	4565	14.7%	14.3%
Sex					
Female	14452	57.8%	18134	58.3%	51.7%
Male	10543	42.2%	12994	41.7%	48.3%
Age (years)					
0-4	430	1.7%	572	1.8%	7.2%
5-9	682	2.7%	982	3.2%	7.0%
10-19	2287	9.1%	2853	9.2%	15.1%
20-29	3866	15.5%	4757	15.3%	16.5%
30-39	3834	15.3%	4659	15.0%	16.3%
40-49	3975	15.9%	4879	15.7%	13.5%
50-59	4015	16.2%	5014	16.1%	11.0%
60-69	3381	13.5%	4259	13.7%	7.5%
70-79	1797	7.2%	2262	7.3%	4.0%
80+	728	2.9%	891	2.9%	2.0%
Color/ethnicity					
White	9493	38.7%	11002	36.1%	45.2%
Brown	11042	45.1%	14265	46.8%	45.1%
Black	2961	12.1%	3917	12.9%	8.9%
Asian	685	2.8%	827	2.7%	0.5%
Indigenous	327	1.3%	439	1.4%	0.4%

Supplementary Table 3. Results from the two survey phases in the 133 cities. Corrected for sample design and test parameters (sensitivity 84.8% and specificity 99.95%).

Region	City	Phase 1 (May 14-21)				Phase 2 (June 4-7)				Change	
		Positives/ Total	Prevalence	95% CI		Positives/ Total	Prevalence	95% CI		% points	P value
North	Altamira	1/232	0.5%	0.0%	2.7%	6/250	2.8%	1.1%	5.7%	2.4%	0.0830
Northeast	Aracaju	1/250	0.4%	0.0%	2.6%	2/250	0.9%	0.1%	3.2%	0.5%	0.6288
Southeast	Araçatuba	0/190	0.0%	0.0%	1.9%	1/250	0.4%	0.0%	2.6%	0.4%	0.6266
North	Araguaína	0/238	0.0%	0.0%	1.5%	2/200	1.1%	0.1%	3.9%	1.1%	0.2835
Northeast	Arapiraca	0/222	0.0%	0.0%	1.6%	6/250	2.8%	1.1%	5.7%	2.8%	0.0244
Southeast	Araraquara	0/121	0.0%	0.0%	3.0%	0/247	0.0%	0.0%	1.5%	0.0%	1.0000
Northeast	Bacabal	2/248	0.9%	0.1%	3.3%	10/250	4.7%	2.0%	9.1%	3.8%	0.0581
Southeast	Barbacena	0/56	0.0%	0.0%	6.4%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
Centre-West	Barra do Garças	0/7	0.0%	0.0%	41.0%	1/250	0.4%	0.0%	2.6%	0.4%	0.9695
Northeast	Barreiras	0/250	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
Southeast	Bauru	0/224	0.0%	0.0%	1.6%	1/250	0.4%	0.0%	2.6%	0.4%	0.6082
North	Belém	32/247	15.3%	9.6%	22.5%	36/250	17.0%	11.1%	24.3%	1.7%	0.7182
Southeast	Belo Horizonte	0/168	0.0%	0.0%	2.2%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
South	Blumenau	0/232	0.0%	0.0%	1.6%	1/239	0.5%	0.0%	2.6%	0.5%	0.5616
North	Boa Vista	10/250	4.7%	2.4%	8.0%	54/250	25.5%	20.1%	31.4%	20.8%	<0.0001
Centre-West	Brasília	0/240	0.0%	0.0%	1.5%	2/250	0.9%	0.1%	3.2%	0.9%	0.3100
North	Breves	53/250	25.0%	18.3%	32.7%	26/250	12.2%	7.0%	19.3%	-12.8%	0.0083
South	Caçador	0/192	0.0%	0.0%	1.9%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
Centre-West	Cáceres	0/208	0.0%	0.0%	1.8%	0/215	0.0%	0.0%	1.7%	0.0%	1.0000
Southeast	Cachoeiro de Itapemirim	0/250	0.0%	0.0%	1.5%	3/250	1.4%	0.3%	3.9%	1.4%	0.1700
Northeast	Caicó	0/5	0.0%	0.0%	52.2%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
Northeast	Campina Grande	0/39	0.0%	0.0%	9.0%	14/250	6.6%	3.8%	10.4%	6.6%	0.0213

Southeast	Campinas	2/236	1.0%	0.1%	3.4%	1/250	0.4%	0.0%	2.6%	-0.6%	0.6075
Centre-West	Campo Grande	0/113	0.0%	0.0%	3.2%	0/203	0.0%	0.0%	1.8%	0.0%	1.0000
Southeast	Campos dos Goytacazes	0/21	0.0%	0.0%	16.1%	2/189	1.2%	0.1%	6.0%	1.2%	0.7843
Northeast	Caruaru	0/37	0.0%	0.0%	9.5%	4/222	2.1%	0.5%	5.6%	2.1%	0.4573
South	Cascavel	1/248	0.4%	0.0%	2.6%	0/250	0.0%	0.0%	1.5%	-0.4%	0.6008
North	Castanhal	33/250	15.5%	10.8%	21.2%	23/250	10.8%	6.9%	15.8%	-4.7%	0.1758
Northeast	Caxias	0/250	0.0%	0.0%	1.5%	1/250	0.4%	0.0%	2.6%	0.4%	0.5978
South	Caxias do Sul	0/249	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
South	Chapecó	0/250	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
Southeast	Colatina	0/221	0.0%	0.0%	1.7%	2/250	0.9%	0.1%	3.2%	0.9%	0.3181
Northeast	Corrente	0/249	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
Centre-West	Corumbá	0/250	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
Northeast	Crateús	2/247	0.9%	0.1%	3.3%	2/250	0.9%	0.1%	3.2%	0.0%	1.0000
South	Criciúma	0/250	0.0%	0.0%	1.5%	0/185	0.0%	0.0%	2.0%	0.0%	1.0000
North	Cruzeiro do Sul	1/250	0.4%	0.0%	2.6%	33/250	15.5%	10.6%	21.6%	15.1%	<0.0001
Centre-West	Cuiabá	0/86	0.0%	0.0%	4.2%	3/250	1.4%	0.3%	3.9%	1.4%	0.3368
South	Curitiba	0/216	0.0%	0.0%	1.7%	0/123	0.0%	0.0%	3.0%	0.0%	1.0000
Southeast	Divinópolis	0/16	0.0%	0.0%	20.6%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
Centre-West	Dourados	0/243	0.0%	0.0%	1.5%	1/250	0.4%	0.0%	2.6%	0.4%	0.6004
Northeast	Feira de Santana	1/66	1.8%	0.1%	8.5%	1/208	0.5%	0.0%	3.0%	-1.3%	0.5837
Northeast	Floriano	0/239	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
South	Florianópolis	1/223	0.5%	0.0%	2.8%	0/205	0.0%	0.0%	1.8%	-0.5%	0.5958
Northeast	Fortaleza	17/225	8.9%	4.7%	14.8%	30/226	15.6%	10.6%	21.7%	6.8%	0.0778
Centre-West	Goiânia	0/235	0.0%	0.0%	1.6%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
Southeast	Governador Valadares	0/34	0.0%	0.0%	10.3%	1/189	0.6%	0.0%	3.3%	0.6%	0.8416
Northeast	Guanambi	0/243	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
South	Guarapuava	0/249	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000

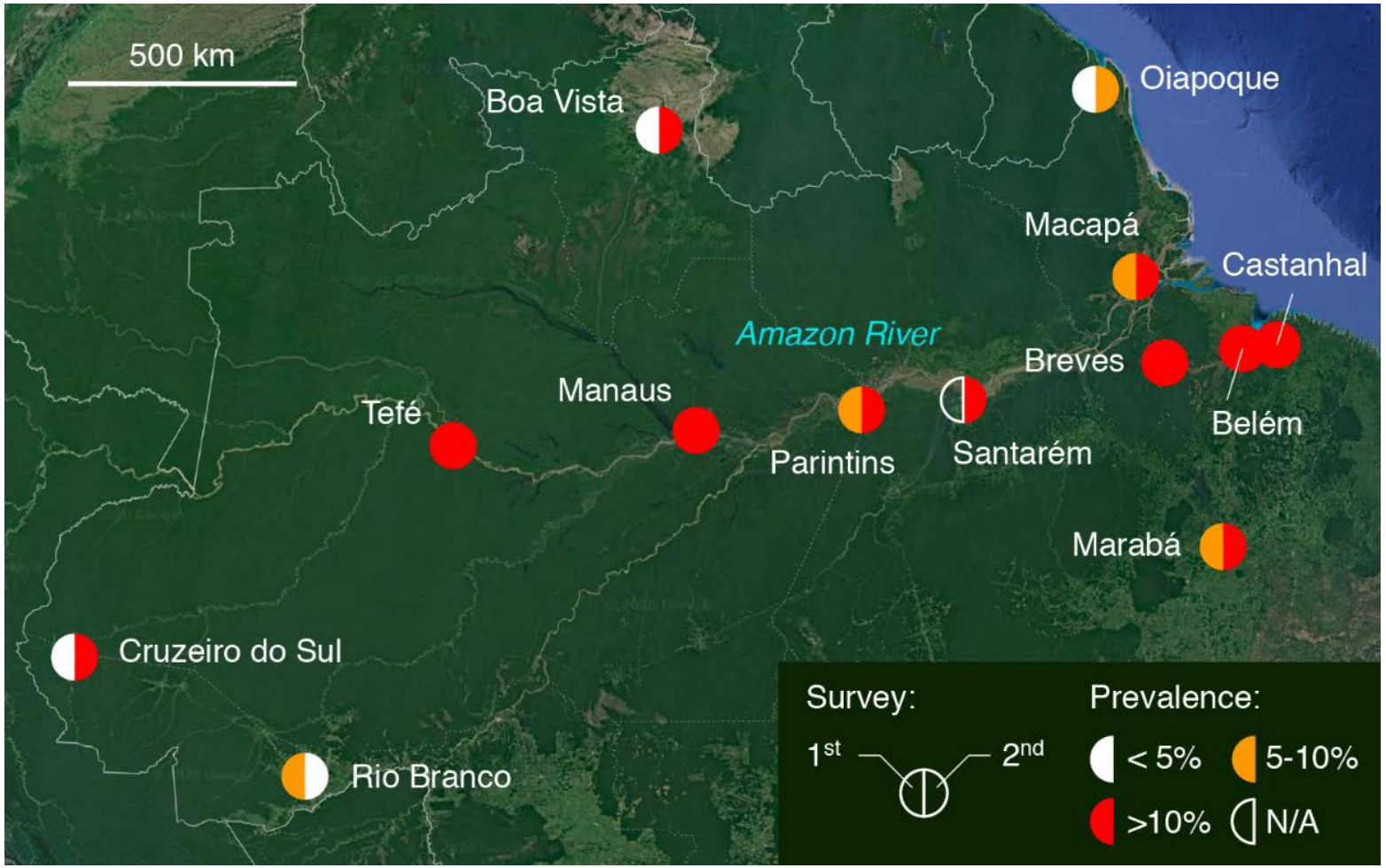
North	Gurupi	0/249	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
Northeast	Iguatu	0/9	0.0%	0.0%	33.6%	2/250	0.9%	0.1%	3.2%	0.9%	0.9168
South	Ijuí	0/240	0.0%	0.0%	1.5%	1/176	0.6%	0.0%	3.3%	0.6%	0.5167
Northeast	Imperatriz	0/41	0.0%	0.0%	8.6%	35/250	16.5%	10.5%	24.0%	16.5%	0.0001
Southeast	Ipatinga	0/82	0.0%	0.0%	4.4%	0/223	0.0%	0.0%	1.6%	0.0%	1.0000
Centre-West	Iporá	0/250	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
Northeast	Irecê	0/41	0.0%	0.0%	8.6%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
Northeast	Itabaiana	0/249	0.0%	0.0%	1.5%	3/250	1.4%	0.3%	3.9%	1.4%	0.1703
Northeast	Itabuna	0/60	0.0%	0.0%	6.0%	1/200	0.6%	0.0%	3.0%	0.6%	0.7472
Centre-West	Itumbiara	0/241	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
North	Ji-Paraná	0/250	0.0%	0.0%	1.5%	2/250	0.9%	0.1%	3.2%	0.9%	0.3063
Northeast	João Pessoa	0/180	0.0%	0.0%	2.0%	13/250	6.1%	3.3%	10.3%	6.1%	0.0010
South	Joinville	0/250	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
Northeast	Juazeiro	0/247	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
Northeast	Juazeiro do Norte	0/106	0.0%	0.0%	3.4%	3/250	1.4%	0.3%	3.8%	1.4%	0.2836
Southeast	Juiz de Fora	1/250	0.4%	0.0%	2.6%	0/250	0.0%	0.0%	1.5%	-0.4%	0.5968
North	Lábrea	0/249	0.0%	0.0%	1.5%	8/250	3.7%	1.7%	6.9%	3.7%	0.0065
South	Lages	0/234	0.0%	0.0%	1.6%	0/215	0.0%	0.0%	1.7%	0.0%	1.0000
South	Londrina	0/243	0.0%	0.0%	1.5%	0/111	0.0%	0.0%	3.3%	0.0%	1.0000
Centre-West	Luziânia	0/177	0.0%	0.0%	2.1%	3/250	1.4%	0.3%	3.9%	1.4%	0.1991
Southeast	Macaé	1/156	0.7%	0.0%	3.6%	1/206	0.5%	0.0%	3.0%	-0.2%	0.8678
North	Macapá	21/250	9.9%	6.4%	14.4%	32/250	15.1%	10.2%	21.1%	5.2%	0.1328
Northeast	Maceió	3/234	1.5%	0.3%	4.0%	26/250	12.2%	8.4%	16.9%	10.8%	<0.0001
North	Manaus	27/250	12.7%	6.8%	20.9%	31/250	14.6%	8.9%	22.1%	1.9%	0.6996
North	Marabá	18/250	8.5%	5.3%	12.6%	22/250	10.4%	6.1%	16.2%	1.9%	0.5512
Southeast	Marília	0/227	0.0%	0.0%	1.6%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
South	Maringá	0/250	0.0%	0.0%	1.5%	0/126	0.0%	0.0%	2.9%	0.0%	1.0000

Southeast	Montes Claros	0/250	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
Northeast	Mossoró	4/138	3.4%	1.0%	7.9%	6/112	6.3%	2.1%	14.0%	2.9%	0.4083
Northeast	Natal	2/229	1.0%	0.1%	3.5%	7/241	3.4%	1.4%	6.6%	2.4%	0.1282
North	Oiapoque	8/250	3.7%	1.3%	8.3%	11/250	5.2%	2.4%	9.6%	1.5%	0.5732
North	Palmas	0/243	0.0%	0.0%	1.5%	1/250	0.4%	0.0%	2.6%	0.4%	0.6004
North	Parintins	11/250	5.2%	2.6%	9.1%	24/250	11.3%	6.5%	17.8%	6.1%	0.0680
Northeast	Parnaíba	0/250	0.0%	0.0%	1.5%	12/250	5.6%	2.4%	10.9%	5.6%	0.0113
South	Passo Fundo	1/250	0.4%	0.0%	2.6%	1/233	0.5%	0.0%	2.8%	0.1%	0.9587
Northeast	Patos	0/42	0.0%	0.0%	8.4%	3/250	1.4%	0.3%	3.8%	1.4%	0.5622
Southeast	Patos de Minas	1/250	0.4%	0.0%	2.6%	0/250	0.0%	0.0%	1.5%	-0.4%	0.5978
Northeast	Paulo Afonso	0/66	0.0%	0.0%	5.4%	1/250	0.4%	0.0%	2.6%	0.4%	0.7945
South	Pelotas	0/247	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
Northeast	Petrolina	0/66	0.0%	0.0%	5.4%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
Southeast	Petrópolis	1/239	0.5%	0.0%	2.6%	1/250	0.4%	0.0%	2.6%	-0.1%	0.9574
Northeast	Picos	City officers did not allow the survey				1/250	0.4%	0.0%	2.6%	-	-
South	Ponta Grossa	4/248	1.9%	0.1%	9.2%	0/234	0.0%	0.0%	1.6%	-1.9%	0.4343
Centre-West	Porangatu	0/200	0.0%	0.0%	1.8%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
South	Porto Alegre	0/248	0.0%	0.0%	1.5%	0/230	0.0%	0.0%	1.6%	0.0%	1.0000
North	Porto Velho	1/173	0.7%	0.0%	3.5%	7/250	3.3%	1.2%	7.0%	2.6%	0.1359
Southeast	Pouso Alegre	0/250	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
Northeast	Presidente Dutra	1/250	0.4%	0.0%	2.6%	18/250	8.5%	4.9%	13.4%	8.1%	0.0004
Southeast	Presidente Prudente	0/116	0.0%	0.0%	3.1%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
Northeast	Quixadá	0/245	0.0%	0.0%	1.5%	3/250	1.4%	0.3%	3.9%	1.4%	0.1743
Northeast	Recife	7/239	3.4%	1.5%	6.6%	6/220	3.2%	0.7%	8.8%	-0.3%	0.9182
North	Redenção	0/250	0.0%	0.0%	1.5%	3/249	1.4%	0.3%	3.8%	1.4%	0.1680
Southeast	Ribeirão Preto	1/239	0.5%	0.0%	2.6%	0/250	0.0%	0.0%	1.5%	-0.5%	0.5552
North	Rio Branco	12/248	5.7%	3.1%	9.3%	10/250	4.7%	2.4%	8.0%	-1.0%	0.6395

Southeast	Rio de Janeiro	5/243	2.4%	0.7%	5.6%	16/250	7.5%	4.5%	11.7%	5.2%	0.0210
Centre-West	Rio Verde	0/201	0.0%	0.0%	1.8%	1/250	0.4%	0.0%	2.6%	0.4%	0.6199
Centre-West	Rondonópolis	0/4	0.0%	0.0%	60.2%	2/147	1.6%	0.2%	5.1%	1.6%	0.9199
North	Rorainópolis	1/151	0.7%	0.0%	3.7%	22/250	10.4%	6.4%	15.6%	9.7%	0.0002
Northeast	Salvador	0/249	0.0%	0.0%	1.5%	10/215	5.5%	2.3%	10.7%	5.5%	0.0124
South	Santa Cruz do Sul	0/250	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
South	Santa Maria	0/250	0.0%	0.0%	1.5%	0/242	0.0%	0.0%	1.5%	0.0%	1.0000
North	Santarém	1/34	3.4%	0.2%	16.3%	23/250	10.8%	7.2%	15.3%	7.4%	0.1082
Northeast	Santo Antônio de Jesus	0/86	0.0%	0.0%	4.2%	City officers did not allow the survey				-	-
Southeast	São José do Rio Preto	0/239	0.0%	0.0%	1.5%	0/94	0.0%	0.0%	3.8%	0.0%	1.0000
Southeast	São José dos Campos	0/51	0.0%	0.0%	7.0%	0/170	0.0%	0.0%	2.1%	0.0%	1.0000
Northeast	São Luís	1/103	1.1%	0.1%	5.5%	13/232	6.6%	3.2%	11.7%	5.5%	0.0341
Southeast	São Mateus	0/24	0.0%	0.0%	14.2%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
Southeast	São Paulo	6/212	3.3%	1.3%	6.7%	5/250	2.3%	0.8%	5.1%	-1.0%	0.5661
Northeast	São Raimundo Nonato	0/247	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
Northeast	Serra Talhada	0/26	0.0%	0.0%	13.2%	2/250	0.9%	0.1%	3.2%	0.9%	0.7952
Centre-West	Sinop	0/22	0.0%	0.0%	15.4%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
Northeast	Sobral	4/232	2.0%	0.5%	5.2%	33/176	22.1%	14.4%	31.4%	20.1%	<0.0001
Southeast	Sorocaba	0/39	0.0%	0.0%	9.0%	1/210	0.5%	0.0%	2.9%	0.5%	0.8364
Northeast	Sousa	0/11	0.0%	0.0%	28.5%	2/250	0.9%	0.0%	4.6%	0.9%	0.9027
North	Tefé	42/250	19.8%	14.9%	25.4%	43/250	20.3%	15.0%	26.4%	0.5%	0.8992
Southeast	Teófilo Otoni	1/242	0.5%	0.0%	2.6%	2/250	0.9%	0.1%	3.2%	0.5%	0.6628
Northeast	Teresina	1/250	0.4%	0.0%	2.6%	3/250	1.4%	0.3%	3.9%	1.0%	0.3980
Southeast	Uberaba	0/250	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
Southeast	Uberlândia	0/235	0.0%	0.0%	1.6%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
South	Uruguaiana	0/250	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000
Southeast	Varginha	0/245	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%	0.0%	1.0000

Southeast	Vitória	3/250	1.4%	0.2%	4.5%	7/250	3.3%	0.9%	8.1%	1.9%	0.3777
Northeast	Vitória da Conquista	0/86	0.0%	0.0%	4.2%	0/249	0.0%	0.0%	1.5%	0.0%	1.0000
Southeast	Volta Redonda	0/207	0.0%	0.0%	1.8%	1/250	0.4%	0.0%	2.6%	0.4%	0.6166

Supplementary Figure 2. Location of the 13 cities in the Amazon region with the highest prevalence in the study. Satellite images are from Google Earth.



Supplementary Table 4. Results from the two survey phases in the 133 cities. Corrected for sample design and test parameters (sensitivity 84.8% and specificity 99.0%).

Region	City	Phase 1 (May 14-21)				Phase 2 (June 4-7)			
		Positives/ Total	Prevalence	95% CI		Positives/ Total	Prevalence	95% CI	
North	Altamira	1/232	0.0%	0.0%	1.0%	6/250	1.7%	0.3%	5.6%
Northeast	Aracaju	1/250	0.0%	0.0%	0.9%	2/250	0.0%	0.0%	1.7%
Southeast	Araçatuba	0/190	0.0%	0.0%	1.9%	1/250	0.0%	0.0%	0.9%
North	Araguaína	0/238	0.0%	0.0%	1.5%	2/200	0.1%	0.0%	26.5%
Northeast	Arapiraca	0/222	0.0%	0.0%	1.6%	6/250	1.7%	0.3%	5.6%
Southeast	Araraquara	0/121	0.0%	0.0%	3.0%	0/247	0.0%	0.0%	1.5%
Northeast	Bacabal	2/248	0.0%	0.0%	1.7%	10/250	3.6%	1.2%	8.1%
Southeast	Barbacena	0/56	0.0%	0.0%	6.4%	0/250	0.0%	0.0%	1.5%
Centre-West	Barra do Garças	0/7	0.0%	0.0%	41.0%	1/250	0.0%	0.0%	0.9%
Northeast	Barreiras	0/250	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%
Southeast	Bauru	0/224	0.0%	0.0%	1.6%	1/250	0.0%	0.0%	0.9%
North	Belém	32/247	14.3%	8.8%	21.5%	36/250	16.1%	10.4%	23.3%
Southeast	Belo Horizonte	0/168	0.0%	0.0%	2.2%	0/250	0.0%	0.0%	1.5%
South	Blumenau	0/232	0.0%	0.0%	1.6%	1/239	0.0%	0.0%	1.0%
North	Boa Vista	10/250	3.6%	1.4%	7.6%	54/250	24.6%	19.4%	30.5%
Centre-West	Brasília	0/240	0.0%	0.0%	1.5%	2/250	0.0%	0.0%	1.7%
North	Breves	53/250	24.2%	17.5%	31.8%	26/250	11.3%	6.3%	18.2%
South	Caçador	0/192	0.0%	0.0%	1.9%	0/250	0.0%	0.0%	1.5%
Centre-West	Cáceres	0/208	0.0%	0.0%	1.8%	0/215	0.0%	0.0%	1.7%
Southeast	Cachoeiro de Itapemirim	0/250	0.0%	0.0%	1.5%	3/250	0.3%	0.0%	6.2%
Northeast	Caicó	0/5	0.0%	0.0%	52.2%	0/250	0.0%	0.0%	1.5%
Northeast	Campina Grande	0/39	0.0%	0.0%	9.0%	14/250	5.6%	2.8%	9.7%

Southeast	Campinas	2/236	0.0%	0.0%	1.8%	1/250	0.0%	0.0%	0.9%
Centre-West	Campo Grande	0/113	0.0%	0.0%	3.2%	0/203	0.0%	0.0%	1.8%
Southeast	Campos dos Goytacazes	0/21	0.0%	0.0%	16.1%	2/189	0.1%	0.0%	26.6%
Northeast	Caruaru	0/37	0.0%	0.0%	9.5%	4/222	1.0%	0.0%	6.1%
South	Cascavel	1/248	0.0%	0.0%	0.9%	0/250	0.0%	0.0%	1.5%
North	Castanhal	33/250	14.6%	10.1%	20.2%	23/250	9.8%	6.1%	14.6%
Northeast	Caxias	0/250	0.0%	0.0%	1.5%	1/250	0.0%	0.0%	0.9%
South	Caxias do Sul	0/249	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%
South	Chapecó	0/250	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%
Southeast	Colatina	0/221	0.0%	0.0%	1.7%	2/250	0.0%	0.0%	1.7%
Northeast	Corrente	0/249	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%
Centre-West	Corumbá	0/250	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%
Northeast	Crateús	2/247	0.0%	0.0%	1.7%	2/250	0.0%	0.0%	1.7%
South	Criciúma	0/250	0.0%	0.0%	1.5%	0/185	0.0%	0.0%	2.0%
North	Cruzeiro do Sul	1/250	0.0%	0.0%	0.9%	33/250	14.6%	9.8%	20.6%
Centre-West	Cuiabá	0/86	0.0%	0.0%	4.2%	3/250	0.3%	0.0%	6.3%
South	Curitiba	0/216	0.0%	0.0%	1.7%	0/123	0.0%	0.0%	3.0%
Southeast	Divinópolis	0/16	0.0%	0.0%	20.6%	0/250	0.0%	0.0%	1.5%
Centre-West	Dourados	0/243	0.0%	0.0%	1.5%	1/250	0.0%	0.0%	0.9%
Northeast	Feira de Santana	1/66	0.7%	0.0%	8.5%	1/208	0.0%	0.0%	1.2%
Northeast	Floriano	0/239	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%
South	Florianópolis	1/223	0.0%	0.0%	1.0%	0/205	0.0%	0.0%	1.8%
Northeast	Fortaleza	17/225	7.9%	4.0%	13.6%	30/226	14.7%	9.9%	20.7%
Centre-West	Goiânia	0/235	0.0%	0.0%	1.6%	0/250	0.0%	0.0%	1.5%
Southeast	Governador Valadares	0/34	0.0%	0.0%	10.3%	1/189	0.0%	0.0%	1.4%
Northeast	Guanambi	0/243	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%
South	Guarapuava	0/249	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%

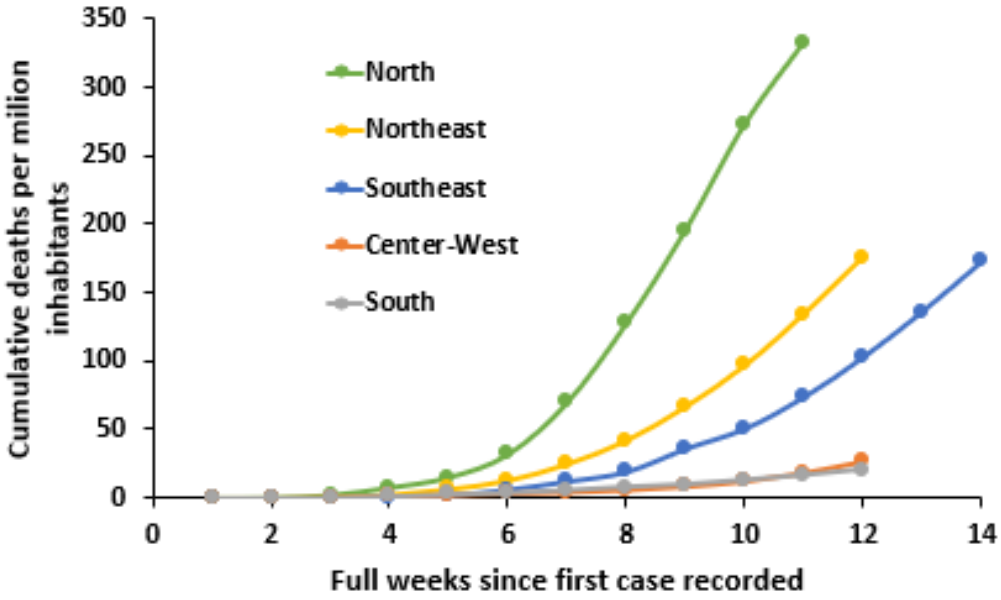
North	Gurupi	0/249	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%
Northeast	Iguatu	0/9	0.0%	0.0%	33.6%	2/250	0.0%	0.0%	1.7%
South	Ijuí	0/240	0.0%	0.0%	1.5%	1/176	0.0%	0.0%	1.6%
Northeast	Imperatriz	0/41	0.0%	0.0%	8.6%	35/250	15.6%	9.8%	23.0%
Southeast	Ipatinga	0/82	0.0%	0.0%	4.4%	0/223	0.0%	0.0%	1.6%
Centre-West	Iporá	0/250	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%
Northeast	Irecê	0/41	0.0%	0.0%	8.6%	0/250	0.0%	0.0%	1.5%
Northeast	Itabaiana	0/249	0.0%	0.0%	1.5%	3/250	0.3%	0.0%	6.3%
Northeast	Itabuna	0/60	0.0%	0.0%	6.0%	1/200	0.0%	0.0%	1.2%
Centre-West	Itumbiara	0/241	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%
North	Ji-Paraná	0/250	0.0%	0.0%	1.5%	2/250	0.0%	0.0%	1.7%
Northeast	João Pessoa	0/180	0.0%	0.0%	2.0%	13/250	5.1%	2.3%	9.4%
South	Joinville	0/250	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%
Northeast	Juazeiro	0/247	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%
Northeast	Juazeiro do Norte	0/106	0.0%	0.0%	3.4%	3/250	0.3%	0.0%	6.2%
Southeast	Juiz de Fora	1/250	0.0%	0.0%	0.9%	0/250	0.0%	0.0%	1.5%
North	Lábrea	0/249	0.0%	0.0%	1.5%	8/250	2.7%	0.8%	6.5%
South	Lages	0/234	0.0%	0.0%	1.6%	0/215	0.0%	0.0%	1.7%
South	Londrina	0/243	0.0%	0.0%	1.5%	0/111	0.0%	0.0%	3.3%
Centre-West	Luziânia	0/177	0.0%	0.0%	2.1%	3/250	0.3%	0.0%	6.3%
Southeast	Macaé	1/156	0.0%	0.0%	1.8%	1/206	0.0%	0.0%	1.2%
North	Macapá	21/250	8.9%	5.4%	13.5%	32/250	14.1%	9.4%	20.1%
Northeast	Maceió	3/234	0.4%	0.0%	5.9%	26/250	11.3%	7.5%	16.0%
North	Manaus	27/250	11.8%	6.1%	19.8%	31/250	13.7%	8.1%	21.0%
North	Marabá	18/250	7.5%	4.3%	11.8%	22/250	9.4%	5.3%	15.0%
Southeast	Marília	0/227	0.0%	0.0%	1.6%	0/250	0.0%	0.0%	1.5%
South	Maringá	0/250	0.0%	0.0%	1.5%	0/126	0.0%	0.0%	2.9%

Southeast	Montes Claros	0/250	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%
Northeast	Mossoró	4/138	2.3%	0.4%	7.1%	6/112	5.3%	1.5%	12.6%
Northeast	Natal	2/229	0.0%	0.0%	1.9%	7/241	2.3%	0.5%	6.3%
North	Oiapoque	8/250	2.7%	0.6%	7.4%	11/250	4.1%	1.6%	8.6%
North	Palmas	0/243	0.0%	0.0%	1.5%	1/250	0.0%	0.0%	0.9%
North	Parintins	11/250	4.1%	1.6%	8.3%	24/250	10.3%	5.7%	16.7%
Northeast	Parnaíba	0/250	0.0%	0.0%	1.5%	12/250	4.6%	1.7%	9.6%
South	Passo Fundo	1/250	0.0%	0.0%	0.9%	1/233	0.0%	0.0%	1.0%
Northeast	Patos	0/42	0.0%	0.0%	8.4%	3/250	0.3%	0.0%	6.3%
Southeast	Patos de Minas	1/250	0.0%	0.0%	0.9%	0/250	0.0%	0.0%	1.5%
Northeast	Paulo Afonso	0/66	0.0%	0.0%	5.4%	1/250	0.0%	0.0%	0.9%
South	Pelotas	0/247	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%
Northeast	Petrolina	0/66	0.0%	0.0%	5.4%	0/250	0.0%	0.0%	1.5%
Southeast	Petrópolis	1/239	0.0%	0.0%	0.9%	1/250	0.0%	0.0%	0.9%
Northeast	Picos	City officers did not allow the survey				1/250	0.0%	0.0%	0.9%
South	Ponta Grossa	4/248	0.8%	0.0%	7.8%	0/234	0.0%	0.0%	1.6%
Centre-West	Porangatu	0/200	0.0%	0.0%	1.8%	0/250	0.0%	0.0%	1.5%
South	Porto Alegre	0/248	0.0%	0.0%	1.5%	0/230	0.0%	0.0%	1.6%
North	Porto Velho	1/173	0.0%	0.0%	1.6%	7/250	2.2%	0.4%	6.6%
Southeast	Pouso Alegre	0/250	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%
Northeast	Presidente Dutra	1/250	0.0%	0.0%	0.8%	18/250	7.5%	4.1%	12.2%
Southeast	Presidente Prudente	0/116	0.0%	0.0%	3.1%	0/250	0.0%	0.0%	1.5%
Northeast	Quixadá	0/245	0.0%	0.0%	1.5%	3/250	0.3%	0.0%	6.3%
Northeast	Recife	7/239	2.4%	0.6%	6.3%	6/220	2.1%	0.3%	7.4%
North	Redenção	0/250	0.0%	0.0%	1.5%	3/249	0.3%	0.0%	6.3%
Southeast	Ribeirão Preto	1/239	0.0%	0.0%	0.9%	0/250	0.0%	0.0%	1.5%
North	Rio Branco	12/248	4.6%	2.1%	8.7%	10/250	3.6%	1.4%	7.6%

Southeast	Rio de Janeiro	5/243	1.3%	0.1%	5.8%	16/250	6.5%	3.5%	10.9%
Centre-West	Rio Verde	0/201	0.0%	0.0%	1.8%	1/250	0.0%	0.0%	0.8%
Centre-West	Rondonópolis	0/4	0.0%	0.0%	60.2%	2/147	0.5%	0.0%	7.5%
North	Rorainópolis	1/151	0.0%	0.0%	1.9%	22/250	9.4%	5.6%	14.5%
Northeast	Salvador	0/249	0.0%	0.0%	1.5%	10/215	4.4%	1.6%	9.3%
South	Santa Cruz do Sul	0/250	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%
South	Santa Maria	0/250	0.0%	0.0%	1.5%	0/242	0.0%	0.0%	1.5%
North	Santarém	1/34	2.4%	0.1%	14.6%	23/250	9.8%	6.3%	14.4%
Northeast	Santo Antônio de Jesus	0/86	0.0%	0.0%	4.2%	City officers did not allow the survey			
Southeast	São José do Rio Preto	0/239	0.0%	0.0%	1.5%	0/94	0.0%	0.0%	3.8%
Southeast	São José dos Campos	0/51	0.0%	0.0%	7.0%	0/170	0.0%	0.0%	2.1%
Northeast	São Luís	1/103	0.0%	0.0%	2.8%	13/232	5.6%	2.5%	10.4%
Southeast	São Mateus	0/24	0.0%	0.0%	14.2%	0/250	0.0%	0.0%	1.5%
Southeast	São Paulo	6/212	2.2%	0.4%	6.4%	5/250	1.3%	0.1%	5.2%
Northeast	São Raimundo Nonato	0/247	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%
Northeast	Serra Talhada	0/26	0.0%	0.0%	13.2%	2/250	0.0%	0.0%	1.7%
Centre-West	Sinop	0/22	0.0%	0.0%	15.4%	0/250	0.0%	0.0%	1.5%
Northeast	Sobral	4/232	0.9%	0.0%	5.7%	33/176	21.2%	13.7%	30.5%
Southeast	Sorocaba	0/39	0.0%	0.0%	9.0%	1/210	0.0%	0.0%	1.1%
Northeast	Sousa	0/11	0.0%	0.0%	28.5%	2/250	0.0%	0.0%	2.4%
North	Tefé	42/250	18.9%	14.1%	24.5%	43/250	19.4%	14.2%	25.4%
Southeast	Teófilo Otoni	1/242	0.0%	0.0%	1.0%	2/250	0.0%	0.0%	1.7%
Northeast	Teresina	1/250	0.0%	0.0%	0.9%	3/250	0.3%	0.0%	6.3%
Southeast	Uberaba	0/250	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%
Southeast	Uberlândia	0/235	0.0%	0.0%	1.6%	0/250	0.0%	0.0%	1.5%
South	Uruguaiana	0/250	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%
Southeast	Varginha	0/245	0.0%	0.0%	1.5%	0/250	0.0%	0.0%	1.5%

Southeast	Vitória	3/250	0.3%	0.0%	8.1%	7/250	2.2%	0.3%	7.1%
Northeast	Vitória da Conquista	0/86	0.0%	0.0%	4.2%	0/249	0.0%	0.0%	1.5%
Southeast	Volta Redonda	0/207	0.0%	0.0%	1.8%	1/250	0.0%	0.0%	0.9%

Supplementary Figure 3. Time trends in reported deaths between the start of the epidemic in each region and May 13, 2020 (source: https://covid.saude.gov.br)



Supplementary table 5. Odds ratios for antibody prevalence according to skin color.

Skin color/ ethnicity	All regions						North region	
	No covariates		Adjusting for region		Adjusting for region, household size and wealth quintiles		No covariates	
	OR	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
	P<0.001		P=0.003		P=0.039		P=0.207	
White	1	Reference	1	Reference	1	Reference	1	Reference
Brown	2.60	2.08 - 3.24	1.30	1.05 - 1.60	1.25	0.92 - 1.69	1.24	0.90 - 1.69
Black	2.42	1.83 - 3.19	1.27	0.97 - 1.66	1.21	0.86 - 1.72	1.28	0.84 - 1.94
Asian	1.47	0.81 - 2.68	0.81	0.49 - 1.33	0.79	0.45 - 1.36	0.54	0.21 - 1.43
Indigenous	4.72	2.91 - 7.67	1.99	1.32 - 3.00	1.87	1.18 - 2.96	1.64	0.87 - 3.10