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Supplementary appendix

This appendix formed part of the original submission and has been peer reviewed. We post it as supplied by the authors.

Supplement to: Murhekar MV, Bhatnagar T, Selvaraju S, et al. SARS-CoV-2 antibody seroprevalence in India, August–September, 2020: findings from the second nationwide household serosurvey. *Lancet Glob Health* 2021; published online Jan 27. http://dx.doi.org/10.1016/S2214-109X(20)30544-1.

Appendix

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Appendix 1. Statistical analysis

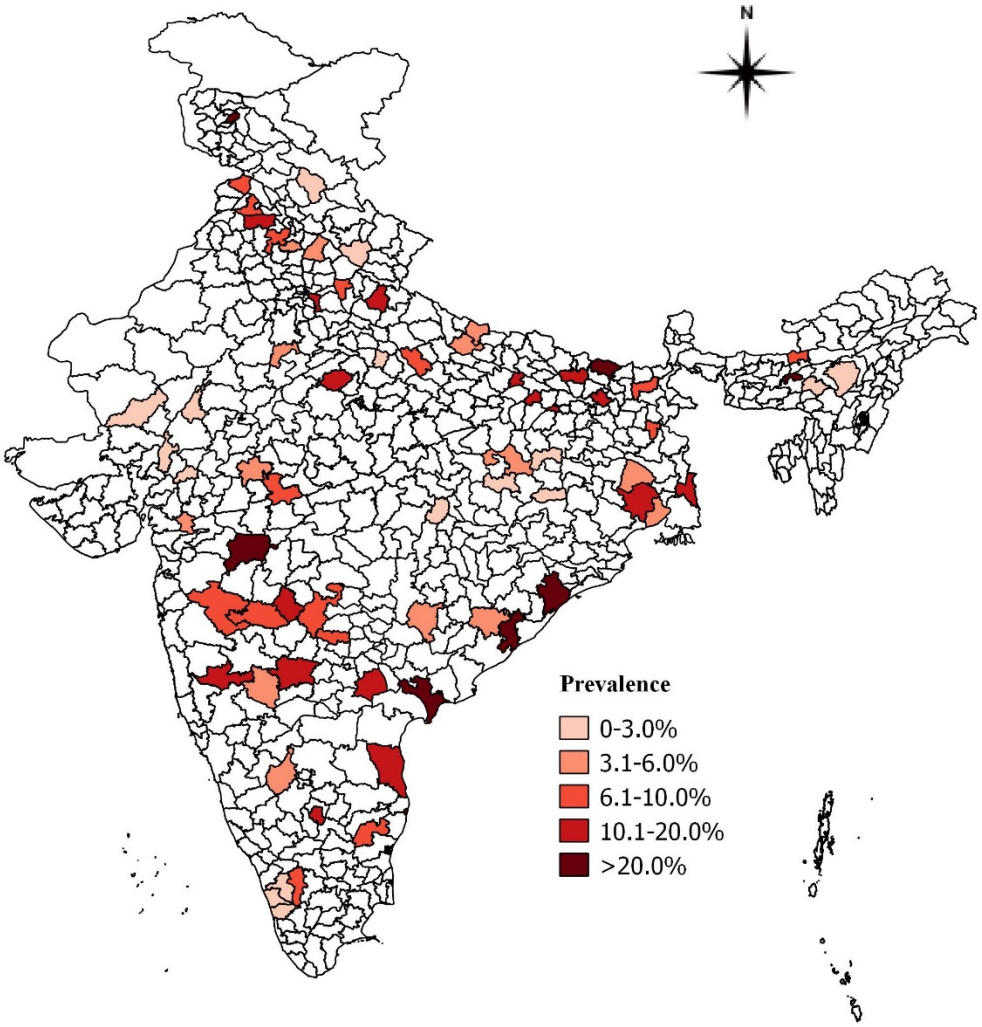
The survey was conducted in 70 randomly selected districts. From each selected district, 10 villages/wards were selected by probability proportional to size method. Design weights were computed by the inverse of product of probabilities at all stages of selection (i.e. selection of villages/wards within districts and households). The design weights were normalized and attached to the master dataset.

Random effects logistic regression model was used to address the clustering effect of estimates by considering district as the level. A random intercept model with design weights was used to estimate the overall seroprevalence. Further, seroprevalence estimates for other factors like Age, Gender, etc were estimated using the same model.

Seroprevalence estimates were obtained by exponentiating the log odds values obtained from the model and converting into probability and its corresponding 95% Wald confidence interval were obtained. The lme4 package from R software was used to perform the analysis.

We fitted a polynomial curve with parabolic and cubic functions to the distribution of incidence of reported cases and seroprevalence.

Appendix 2. Figure: Unweighted proportion of individuals with SARS-CoV-2 IgG antibodies by districts, Second national SARS-CoV-2 household serosurvey, India, August – September 2020



Appendix 3: Unweighted proportion of individuals (overall and adults) with SARS-CoV-2 IgG antibodies by districts, First and second national SARS-CoV-2 serosurvey, India 2020

State	District	Serosurvey -1 Adults (May- June 2020)		Serosurvey – 2 Randomly selected adults (Aug- Sep 2020)		Serosurvey -2 Overall (Aug- Sep 2020)		Incidence (per 100,000) of reported COVID-19 cases (Aug 18)
		No. tested	No. positive (%)	No. tested	No. positive (%)	No. tested	No. positive (%)	
Andhra Pradesh	Vizianagaram	400	6 (1.50)	222	81 (36.5)	418	159 (38.0)	7578.3
	Krishna	397	1 (0.25)	265	77 (29.1)	399	117 (29.3)	3297.2
	SPS Nellore	395	1 (0.25)	236	48 (20.3)	428	76 (17.8)	6823.1
Assam	Karbi Anglong	400	0	201	5 (2.5)	418	11 (2.6)	1331.2
	Udalguri	400	0	215	17 (7.9)	412	31 (7.5)	1081.9
	Kamrup Metropolitan	400	0	242	57 (23.6)	435	91 (20.9)	16250.2
Bihar	Madhubani	398	4 (1.00)	252	59 (23.4)	430	102 (23.7)	712.7
	Purnia	400	4 (1.00)	224	28 (12.5)	420	42 (10.0)	950.8
	Begusarai	400	1 (0.25)	178	25 (14.0)	429	62 (14.4)	1574.6
	Muzaffarpur	400	2 (0.5)	196	36 (18.4)	420	69 (16.4)	1003.8
	Arwal	398	5 (1.26)	188	30 (16.0)	408	69 (16.9)	1225.7
	Buxar	400	5 (1.25)	225	26 (11.6)	422	55 (13.0)	1271.9

State	District	Serosurvey -1 Adults (May- June 2020)		Serosurvey – 2 Randomly selected adults (Aug- Sep 2020)		Serosurvey -2 Overall (Aug- Sep 2020)		Incidence (per 100,000) of reported COVID-19 cases (Aug 18)
		No. tested	No. positive (%)	No. tested	No. positive (%)	No. tested	No. positive (%)	
Chhattisgarh	Bijapur	403	3 (0.74)	293	16 (5.5)	400	22 (5.5)	639.6
	Kabeerdham	406	1 (0.25)	288	5 (1.7)	401	7 (1.7)	434.4
	Surguja	401	0	260	2 (0.8)	398	5 (1.3)	824.9
Gujarat	Sabar Kantha	400	0	252	6 (2.4)	402	10 (2.5)	260.0
	Narmada	399	1 (0.25)	266	10 (3.8)	399	13 (3.3)	1160.3
	Mahisagar	400	1 (0.25)	236	5 (2.1)	404	10 (2.5)	603.2
Haryana	Kurukshetra	400	1(0.25)	209	12 (5.7)	400	20 (5.0)	1139.8
Himachal Pradesh	Kullu	405	0	312	2 (0.6)	399	2 (0.5)	532.6
Jammu & Kashmir	Pulwama	400	3 (0.75)	221	53 (24.0)	413	113 (27.4)	3601.4
Jharkhand	Pakur	397	3 (0.76)	176	21 (11.9)	401	40 (10.0)	462.6
	Latehar	398	1 (0.25)	131	3 (2.3)	401	11 (2.7)	1050.1
	Simdega	399	4 (1.00)	225	4 (1.8)	399	5 (1.3)	1340.4

State	District	Serosurvey -1 Adults (May- June 2020)		Serosurvey – 2 Randomly selected adults (Aug- Sep 2020)		Serosurvey -2 Overall (Aug- Sep 2020)		Incidence (per 100,000) of reported COVID-19 cases (Aug 18)
		No. tested	No. positive (%)	No. tested	No. positive (%)	No. tested	No. positive (%)	
Karnataka	Chitradurga	400	0	209	17 (8.1)	432	26 (6.0)	1202.1
	Bengaluru Urban	400	2 (0.50)	234	44 (18.8)	436	81 (18.6)	10450.2
	Gulbarga	399	1 (0.25)	222	45 (20.3)	419	79 (18.9)	3830.2
Kerala	Thrissur	400	3 (0.75)	211	4 (1.9)	433	5 (1.2)	631.8
	Ernakulam	394	1 (0.25)	186	3 (1.6)	418	4 (1.0)	1085.7
	Palakkad	399	0	193	0	430	2 (0.5)	603.0
Madhya Pradesh	Gwalior	402	4 (1.00)	193	26 (13.5)	438	54 (12.3)	2022.1
	Ujjain	407	5 (1.23)	217	9 (4.1)	418	15 (3.6)	831.5
	Dewas	401	0	234	12 (5.1)	395	27 (6.8)	452.9
Maharashtra	Bid	396	2 (0.51)	183	16 (8.7)	443	33 (7.4)	1169.4
	Parbhani	396	3 (0.76)	194	30 (15.5)	480	73 (15.2)	1010.9
	Nanded	393	4 (1.02)	222	23 (10.4)	439	43 (9.8)	1444.6
	Sangli	400	4 (1.00)	182	23 (12.6)	467	55 (11.8)	2805.8
	Ahmadnagar	404	4 (1.00)	201	15 (7.5)	447	39 (8.7)	3188.1
	Jalgaon	396	2 (0.50)	175	44 (25.1)	405	105 (25.9)	4720.4

State	District	Serosurvey -1 Adults (May- June 2020)		Serosurvey – 2 Randomly selected adults (Aug- Sep 2020)		Serosurvey -2 Overall (Aug- Sep 2020)		Incidence (per 100,000) of reported COVID-19 cases (Aug 18)
		No. tested	No. positive (%)	No. tested	No. positive (%)	No. tested	No. positive (%)	
Odisha	Ganjam	400	3 (0.75)	293	129 (44.0)	418	178 (42.6)	4343.8
	Rayagada	399	1 (0.25)	286	69 (24.1)	404	98 (24.3)	3017.8
	Koraput	403	3 (0.74)	240	13 (5.4)	401	18 (4.5)	1719.8
Punjab	Gurdaspur	400	0	224	17 (7.6)	400	33 (8.3)	635.9
	Ludhiana	400	0	213	45 (21.1)	399	75 (18.8)	2840.4
	Patiala	399	3 (0.75)	188	15 (8.0)	399	33 (8.3)	1495.7
	Jalandhar	400	0	219	18 (8.2)	400	39 (9.8)	2157.4
Rajasthan	Rajsamand	396	2 (0.51)	222	4 (1.8)	409	7 (1.7)	882.3
	Jalor	395	2 (0.51)	155	4 (2.6)	396	7 (1.8)	557.9
	Dausa	397	4 (1.00)	171	6 (3.5)	407	13 (3.2)	293.8
Tamil Nadu	Tiruvannamalai	400	5 (1.25)	265	27 (10.2)	410	35 (8.5)	3532.2
	Coimbatore	400	5 (1.25)	259	22 (8.5)	428	31 (7.2)	3000.9
	Chennai	400	6 (1.51)	258	94 (36.4)	421	141 (33.5)	19024.4
Telangana	Jangoan	405	0	181	29 (16.0)	454	83 (18.3)	424.1
	Kamareddy	404	1 (0.25)	200	13 (6.5)	433	30 (6.9)	484.3
	Nalgonda	403	1 (0.25)	180	18 (10.0)	422	47 (11.1)	700.0

State	District	Serosurvey -1 Adults (May- June 2020)		Serosurvey – 2 Randomly selected adults (Aug- Sep 2020)		Serosurvey -2 Overall (Aug- Sep 2020)		Incidence (per 100,000) of reported COVID-19 cases (Aug 18)
		No. tested	No. positive (%)	No. tested	No. positive (%)	No. tested	No. positive (%)	
Uttar Pradesh	Balrampur	407	2 (0.49)	106	5 (4.7)	408	14 (3.4)	1058.7
	Gonda	403	1 (0.25)	161	3 (1.9)	413	13 (3.1)	473.9
	Bareilly	408	3 (0.74)	214	23 (10.7)	400	48 (12.0)	997.9
	Unnao	402	1 (0.25)	190	15 (7.9)	400	26 (6.5)	409.9
	Mau	423	2 (0.47)	154	17 (11.0)	406	53 (13.1)	435.8
	Auraiya	383	1 (0.26)	219	4 (1.8)	400	4 (1.0)	607.7
	Gautam Buddha Nagar	398	3 (0.75)	192	32 (16.7)	400	50 (12.5)	4807.4
	Saharanpur	391	1 (0.26)	181	4 (2.2)	402	18 (4.5)	605.3
	Jyotiba Phule Nagar	401	1 (0.25)	182	11 (6.0)	399	30 (7.5)	613.5
Uttarakhand	Garhwal	400	1 (0.25)	266	7 (2.6)	400	9 (2.3)	598.7
West Bengal	Alipurduar	400	5 (1.25)	220	27 (12.3)	425	61 (14.4)	690.6
	Bankura	400	2 (0.50)	192	5 (2.6)	422	20 (4.7)	463.5
	Jhargram	400	1 (0.25)	224	11 (4.9)	428	15 (3.5)	180.4
	24 Paraganas South	400	12 (3.00)	229	38 (16.6)	418	71 (17.0)	1094.3
	Medinipur East	400	2 (0.50)	231	32 (13.9)	404	52 (12.9)	970.9

Appendix 4. Age and sex characteristics of individuals by enrolment status, Second national SARS-CoV-2 serosurvey, India, August – September 2020

Characteristic	Number of individuals participated in the survey (%)	Number of individuals refused to participate in the survey (%)	P value (chi-square test)
Age (Years)	(n=29,082)	(n=6,133)	
10 – 17	3,021 (10.4)	658 (10.7)	0.0001
18 – 44	16,663 (57.3)	3495 (57.0)	
45 – 60	6,630 (22.8)	1582 (25.8)	
Above 60	2,768 (9.5)	398 (6.5)	
Sex	(n=29,061)	(n=6,127)	
Male	14,870 (51.1)	3710 (60.5)	0.0001
Female	14,191 (48.8)	2417 (39.4)	
Others	21 (0.1)	6 (0.1)	

Appendix 5. Estimated number of infections among individuals aged 10 years above and infection fatality ratio using test characteristics published by manufacturer and external evaluation

	Estimate (95% CI)[1]	**Estimate (95% CI)[2]**
Estimated number of infections	74,326,463 (65,317,195 - 83,335,732)	85,038,940 (75,320,204 - 94,757,676)
Number of reported COVID-19 cases (10 Aug)	2,339,112	2,339,112
Infection Case ratio (10 Aug)	**31.8 (27.9 - 35.6)**	**36.4 (32.2 - 40.5)**
Number of reported COVID-19 cases (18 Aug)	2,856,248	2,856,248
Infection Case ratio (18 Aug)	**26.0 (22.9 – 29.2)**	**29.8 (26.4 – 33.2)**
Number of deaths (31 Aug)	10,058	10,058
Infection fatality ratio per 10,000 (31 Aug)	**9.43 (8.41 – 10.73)**	**8.24 (7.40 – 9.31)**
Number of deaths (8 Sept)	11,358	11,358
Infection fatality ratio per 10,000 (8 Sept)	**10.65 (9.50 – 12.12)**	**9.31 (8.35 – 10.51)**

[1] Based on sensitivity (100%) and specificity (99.6%) as per manufacturer

[2]Based on sensitivity (92.7%) and specificity (100%) as per external evaluation (Ref: National SARS-CoV-2 Serology Assay Evaluation Group. Performance characteristics of five immunoassays for SARS-CoV-2: a head-to-head benchmark comparison. Lancet Infect Dis. 2020 Sep 23:S1473-3099(20)30634-4)

Appendix 6. Prevalence of SARS-CoV-2 in various cities/states, India, 2020[1]

City	Study setting	Samples tested	Study period	Seroprevalence (%)
Delhi (Round-1)	Urban	21,387	Jun 27-Jul 10	23.48
Delhi (Round-2)	Urban	15,000	Aug 1-7	29.1
Delhi (Round-3)	Urban	17,409	Sept 1-5	25.1
Mumbai[2]	Urban	6,904	Jun 29 – Jul 19	54.1 (slums), 16.1 (non-slum)
Pune	Urban	1664	Jul 20-Aug 5	51.5
Ahmedabad (Round 1)	Urban	30.054	Jun 16- Jul 11	17.6
Ahmedabad (Round 2)	Urban	10,310	Aug 15-29	23.24
Chennai (Round 1)	Urban	12,405	Jul 17-28	18.4
Chennai (Round 2)	Urban	6366	Oct 8-15	30.1
Puducherry (Round-1)	Rural and Urban	869	Aug 11-16	4.9
Puducherry (Round-2)	Rural and Urban	898	Sept 10-16	20.7
Indore	Urban	7100	Aug 11-23	7.75%
District Kashmir[3]	Rural and Urban (facility based)	2906	July 1-15	3.6
Jammu and Kashmir (10 districts)	Rural and Urban	6230	October	38.8
Karnataka (30 districts)	Rural and Urban	15,624	Sept 3-16	16.4

[1]Compiled from various media sources/unpublished data

[2]Malani A, Shah D, Kang G, Lobo GN, Shastri J, Mohanan M, Jain R, Agrawal S, Juneja S, Imad S, Kolthur-Seetharam U. Seroprevalence of SARS-CoV-2 in slums versus non-slums in Mumbai, India. Lancet Glob Health. 2020 Nov 13:S2214-109X(20)30467-8.

[3]Khan SMS, Qurieshi MA, Haq I, Majid S, Bhat AA, Nabi S, Ganai NA, Zahoor N, Nisar A, Chowdri IN, Qazi TB, Kousar R, Lone AA, Sabah I, Nabi S, Sumji IA, Kawoosa MF, Ayoub S. Seroprevalence of SARS-CoV-2 specific IgG antibodies in District Srinagar, northern India - A cross-sectional study. PLoS One. 2020 Nov 11;15(11):e0239303.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	1,2
Objectives	3	State specific objectives, including any prespecified hypotheses	2
Methods			
Study design	4	Present key elements of study design early in the paper	2
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	2,3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	3
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	3
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	NA
Bias	9	Describe any efforts to address potential sources of bias	NA
Study size	10	Explain how the study size was arrived at	3
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	3
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	NA
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	NA
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	Appendix 1
		(*e*) Describe any sensitivity analyses	Appendix 5
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	
		(b) Give reasons for non-participation at each stage	

		(c) Consider use of a flow diagram	Fig1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1
		(b) Indicate number of participants with missing data for each variable of interest	Table 1
Outcome data	15*	Report numbers of outcome events or summary measures	Table 2
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Table 2
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	5
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	7
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	5,6
Generalisability	21	Discuss the generalisability (external validity) of the study results	7
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	1

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.