

Antibodies Against SARS-CoV-2 among High-Risk Groups: Findings from Serosurveys in 6 Urban Areas of Odisha, India

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Research Article

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Abstract

Background: Personnel involved in essential services or residing in high risk areas during the COVID-19 pandemic are at increased risk of getting infected, and higher infection rates among such personnel can paralyze these services due to shortage of staff. Evaluating the proportion of personnel infected can be done using seroprevalence studies or serosurveys.

Methods: During July to November, 2020, individuals from multiple high risk groups in 6 urban centres in the state of Odisha, India, which included health care workers, police personnel, municipality/ sanitation staff, residents of urban slums, vendors, press staff, and prisoners, were recruited into the study after obtaining written informed consent. Blood samples collected from the study participants were tested for IgG antibodies against COVID-19 in Roche Cobas e441. Information on socio-demographic variables, association with a confirmed or suspected case, symptoms profile of individuals within 30 days, travel and history of testing for COVID-19 were collected. All the statistical analyses were performed using STATA 16.0 (Stata corp., Texas). A P value ≤ 0.05 was considered statistically significant.

Results: Of the 5434 individuals included in the final analysis, the overall COVID-19 seroprevalence was found to be 34.9% (95% CI 33.6-36.2). The seroprevalence varied from 21.8% (95% CI 19.6-24.1) in Rourkela to 54.9% (95% CI 51.5-58.2) in Bhubaneswar. Seropositivity was maximum among prisoners (47.7%, 138/289), followed by municipality/ sanitation staff (43.5%, 330/758), other office going staff (40.8%, 183/448), slum residents and vendors (39.8%, 252/633), police personnel (38.3%, 354/922), health care workers (27.1%, 536/1977), press staff (27.2%, 18/66) and residents of containment zones (25.2%, 86/341). On multivariate logistic regression, participants aged 18-29 years, 30-44 years, residents of slums and vending zone, municipality staffs, prisoners, residents of urban sites Malkangiri, Cuttack, Paralakhemundi and Bhubaneswar and those with previous history of confirmed COVID-19 were found to be independent co-relates of seropositivity.

Conclusions: Risk of COVID-19 infection varied among the various high risk groups of Odisha. Periodic seroprevalence studies in future is essential to protect personnel involved in frontline activities during the ongoing pandemic.

Background

Coronavirus disease 2019 (COVID-19), caused by the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), has resulted in more than 177 million infections globally, with more than 3.8 million deaths [1]. In India, as on 20th June 2021, more than 29 million people have been infected with SARS-CoV-2, with approximately 3.8 lakhs deaths due to COVID-19 [2]. High load of COVID-19 patients due to the high transmissibility of SARS-CoV-2 has led to overwhelming of the health care systems globally [3]. High infection rates among personnel involved in essential services such as health care workers, police personnel, municipality/ sanitation staff, etc, can lead to paralysis of these essential services due to shortage of staff. To understand the burden of COVID-19 infection among health care workers, seroprevalence studies or serosurveys have been reported from several countries [4–9]. However, very few studies have evaluated COVID-19 seroprevalence among personnel involved in other high risk but essential services during the pandemic [10].

In India, two large sequential cross-sectional serosurveys have evaluated the COVID-19 seroprevalence at the community level. The first serosurvey, conducted during May-June, 2020, involving 28000 individuals, reported a seroprevalence of 0.73% (95% CI: 0.34–1.13) [11]. The second national serosurvey, conducted during August-September, 2020, which involved more than 29000 individuals, reported a seroprevalence of 6.6% (95% CI: 5.8–7.4) [12]. In a serial, three round, community based serosurvey reported from Bhubaneswar, the capital city of the state of Odisha, India, the seroprevalence increased from 1.55% in the first survey, to 5.27% and 49.04% in the second and third serosurveys respectively [13].

Very few studies from India have evaluated the seroprevalence against SARS-CoV-2 among health care workers [14]. In this study from six urban centres of Odisha, India, we have evaluated the seroprevalence against SARS-CoV-2 in multiple high risk groups, which included health care workers, police personnel, municipality/ sanitation staff, residents of urban slums, vendors, press staff, and prisoners, during July-November, 2020.

Methods

Study design and participants

This was a cross sectional serological survey carried out between July and November, 2020, in six urban sites of the state of Odisha in eastern India. The six sites were Bhubaneswar (capital city of Odisha), Berhampur, Cuttack, Malkangiri, Paralakhemundi, and Rourkela (Fig. 1). The study population included different high-risk groups such as health care workers, municipality and sanitary staffs, media personnel, police and security personnel, vendors, residents of slums, residents of containment zones and prisoners. We followed purposive sampling method for this study as the groups mentioned above were difficult to access in a probability sampling method due to the COVID-19 pandemic situation.

Data collection

Data was collected on several parameters such as socio-demographic variables, association with a confirmed or suspected case, symptoms profile of individuals within 30 days, travel and history of testing for COVID-19. Several trained data entry operators conducted the participant interviews using an electronic data capture tool based on Open Data Kit.

Sample collection and testing

All the precautionary measures and COVID-19 protocols were followed for collection of 3–4 ml blood sample from each study participant in vacutainers by phlebotomy technicians. The blood samples collected were transported to the laboratory at the Indian Council of Medical Research (ICMR)- Regional Medical Research Centre (RMRC), in Bhubaneswar under cold conditions (4°C) for further analysis.

Presence of IgG antibodies against COVID-19 was detected by testing of the serum samples in Roche Cobas e441 (Roche Diagnostics, Rotkreuz, Switzerland). Electro-chemiluminescence immunoassay (ECLIA) based technique, which is based on test principle of double-antigen sandwich assay, was used for detection of antibodies against COVID-19 in human serum. Testing procedures were followed as per the manufacturer's instructions. A cut off index value was designated by the device for presence or absence of antibodies in serum. Less than one indicated absence of antibodies in serum and more than or equal to one indicated presence of antibodies in serum.

Statistical Analysis

The seroprevalence of COVID-19 infection was estimated as proportion along with 95% confidence intervals (95% CI) and its distribution assessed across cities. Sociodemographic factors such as age group, sex, types of occupation and urban site of residence were presented as frequencies. History of travel, flu like symptoms, COVID-19 testing status during the previous 30 days were also evaluated. Co-relates of COVID-19 seroprevalence were assessed using multivariate binary logistic regression model. Adjusted odd's ratio (aOR) and 95% CI were calculated for each predictor variable. A P value ≤ 0.05 was considered statistically significant. All the statistical analyses were performed using STATA 16.0 (Stata corp., Texas).

Ethics

Participants who were involved in professional duties in their respective groups since at least the previous 3 months, and who agreed to provide written informed consent for data and sample collection were included in the study. Interviews were conducted ensuring privacy. All the data was captured in an electronic database under the investigator's supervision to ensure the privacy of the participants. Approval for the protocol was obtained from the ICMR-RMRC Institutional Human Ethics Committee and the State Health and research ethics committee.

Results

A total of 5480 participants from the six urban sites of the state were recruited into the study during July to November, 2020. After data scrutiny and rejection of leaked or inadequate samples, 5434 (99.2%, 5434/5480) high risk group individuals were included in the final analysis. Majority of them were in the age group 30–44 years (43.2%) followed by 45–59 years (32.7%) (Table 1). The mean age was 40.4 (11.6) years and 64.2% (3487/5434) were males. The maximum number of participants were from Berhampur (26.8%, 1455/5434), followed by Rourkela (24.4%, 1327/5434) (Table 1). More than one third survey participants were health care workers (36.4%, 1977/5434), followed by police (17%, 922/5434) and municipality staff (13.9%, 758/5434). 11.6% (633/5434) were from either slums or vending zones and 6.3% (341/5434) were residents of containment zones. 5.3% (289/5434) of the participants were prisoners.

Table 1
Characteristics of survey participants (n = 5434)

Characteristics		n (%)
Age group (in years)	18–29	1068 (19.7)
	30–44	2346 (43.2)
	45–59	1777 (32.7)
	>=60	243 (4.5)
Gender	Male	3487 (64.2)
	Female	1947 (35.8)
High risk group	Office Staff	448 (8.2)
	Slum/Vendors	633 (11.6)
	Containment zone resident	341 (6.3)
	Health Care Workers	1977 (36.4)
	Municipal staff	758 (13.9)
	Police staff	922 (17.0)
	Press staff	66 (1.2)
	Prisoners	289 (5.3)
Urban Sites	Paralakhemundi	531 (9.8)
	Berhampur	1455 (26.8)
	Bhubaneswar	886 (16.3)
	Malkangiri	595 (10.9)
	Rourkela	1327 (24.4)
	Cuttack	640 (11.8)
Travel H/O since last 30 days	Yes	313 (5.8)
Any flu like symptoms in last 30 days	Yes	489 (9.0)
Tested for COVID-19	Yes	2593 (47.7)
H/O COVID-19 infection/disease	Yes	489 (9.0)
H/O COVID-19 disease in family	Yes	223 (4.1)

9% (489/5434) participants had flu like symptoms during the previous 30 days. 47.7% (2593/5434) study participants had undergone testing for COVID-19 before the survey, and 9% (489/5434) were positive for COVID-19, confirmed either by real-time PCR (qRT-PCR) or by rapid antigen test (RAT). Confirmed cases of COVID-19 infection/disease in any of the family members were reported in 4.1% (223/5434) of the study participants. (Table-1).

During July to November, 2020, 1897 out of the 5434 study participants had detectable antibodies against SARS-CoV-2. This represented an overall seropositivity of 34.9% (95% CI 33.6–36.2) among the study participants from the high risk groups in our study. The COVID-19 seroprevalence varied from 21.8% (95% CI 19.6–24.1) in Rourkela to 54.9% (95% CI 51.5–58.2) in Bhubaneswar (Fig. 2).

The seroprevalence of each high risk group across the 6 urban sites are provided in Table 2. Seropositivity was maximum among prisoners (47.7%, 138/289), although it included participants only from Berhampur and Rourkela. This was followed by seropositivity among municipality/ sanitation staff (43.5%, 330/758), other office going staff (40.8%, 183/448), slum residents and vendors (39.8%, 252/633), police personnel (38.3%, 354/922), health care workers (27.1%, 536/1977), press staff (27.2%, 18/66) and residents of containment zones (25.2%, 86/341).

Table 2
COVID-19 seroprevalence in high risk groups across six urban sites of Odisha, August-November 2020

High risk Group	Berhampur		Rourkela		Paralakhemundi		Malkangiri		Bhubaneswar		Cuttack		Overall
	N	% (95% CI)	N	% (95% CI)	N	% (95% CI)	N	% (95% CI)	N	% (95% CI)	N	% (95% CI)	
Health Care Worker	60/517	11.6 (9–14.6)	52/541	9.6 (7.2–12.4)	81/164	49.3 (41.5–57.2)	81/214	37.8 (31.3–44.7)	179/346	51.7 (46.3–57.1)	83/195	42.5 (35.5–49.8)	536/1977
Police	50/228	21.9 (16.7–27.8)	46/195	23.5 (17.8–30.1)	54/100	54 (43.7–64.0)	56/95	58.9 (48.3–68.9)	79/151	52.3 (44.0–60.4)	69/153	45.09 (37.0–53.3)	354/603
Municipality Staff	46/165	27.8 (21.1–35.3)	44/145	30.3 (22.9–38.52)	29/61	47.5 (34.5–60.7)	13/25	52 (31.3–72.2)	139/237	58.6 (52.0–64.9)	59/125	47.2 (38.2–56.3)	330/699
Office Staff	-	-	-	-	66/149	44.2 (36.1–52.6)	52/147	35.3 (27.6–43.6)	-	-	65/152	42.76 (34.7–51.0)	183/414
Slum/Vendor	72/205	35.1 (28.6–42.0)	71/226	31.4 (25.4–37.9)	20/50	40 (26.4–54.8)	-	-	89/152	58.5 (50.2–66.4)	-	-	252/427
Containment Zone	29/122	23.7 (16.5–32.3)	15/114	13.1 (7.5–20.7)	-	-	42/105	40 (30.5–50.0)	-	-	-	-	86/217
Prisoners	83/207	40.0 (33.3–47.1)	55/82	67.0 (55.8–77)	-	-	-	-	-	-	-	-	138/209
Press Staff	1/11	9.0 (0.22–41.2)	6/24	25 (9.7–46.7)	6/7	85.7 (42.1–99.6)	2/9	22.2 (2.81–60.0)	-	-	3/15	20 (4.3–48.0)	18/47
Total	341/1455	23.4 (25.7–21.3)	289/1327	21.8 (19.5–24.0)	256/531	48.2 (43.5–52.5)	246/595	41.3 (37.3–45.4)	486/886	54.8 (51.5–58.1)	279/640	43.5 (39.7–47.5)	189/434

Among the health care workers, maximum seropositivity was observed in the capital city, Bhubaneswar (51.7%, 179/346), followed by Paralakhemundi (49.3%, 81/164) (Table 2). Among police personnel, the maximum proportion of seropositive individuals was found in Malkangiri (58.9%, 56/95), followed by Paralakhemundi (54%, 54/100), Bhubaneswar (52.3%, 79/151) and Cuttack (45.1%, 69/153) (Table 2). The seropositivity among municipality/sanitation staff ranged from 27.8% (46/165) in Berhampur to 58.6% (139/237) in Bhubaneswar (Table 2). The seropositivity among prisoners was highest in Rourkela (67%, 55/82), followed by Berhampur (40%, 83/207) (Table 2).

On multivariate logistic regression, participants aged 18–29 years (adj. OR = 1.43), 30–44 years (adj. OR = 1.54), residents of slums and vending zone (adj. OR = 2.18), municipality staffs (adj. OR = 1.7), prisoners (adj. OR = 4.47), residents of urban sites Malkangiri (adj. OR = 3.13), Cuttack (adj. OR = 3.77), Paralakhemundi (adj. OR = 4.18) and Bhubaneswar (adj. OR = 5.09) and those with previous history of confirmed COVID-19 (adj. OR = 11.4) were found to be independent co-relates of seropositivity (Table 3).

Table 3

Co-relates of COVID-19 seropositivity among high risk group population across six urban sites of Odisha, India 2020 (n = 5434)

Variables		Sero-prevalence (%)	aOR	95% C.I.for EXP(B)		p-value
				Lower	Upper	
Age Category	18–29 years	34.5	1.43	1.01	2.03	0.042
	30–44 years	37.5	1.54	1.11	2.15	0.009
	45–59 years	32.9	1.18	.84	1.65	0.324
	≥ 60 years	27.2	Ref.			
Participant gender	Female	33.0	Ref.			Ref.
	Male	36.0	.91	.79	1.06	0.237
High risk group	Office staffs	40.8	Ref.			
	Vendors and Slums	39.8	2.18	1.61	2.95	<0.001
	Containment zone	25.2	0.84	0.58	1.22	0.377
	Health care workers	27.1	0.87	0.68	1.12	0.302
	Municipality staffs	43.5	1.70	1.29	2.25	<0.001
	Police staffs	38.4	1.29	0.99	1.68	0.057
	Press staffs	27.3	1.11	0.60	2.06	0.730
	Prisons	47.8	4.47	3.08	6.49	<0.001
District	Rourkela	21.8	Ref.			
	Cuttack	43.6	3.77	2.97	4.78	<0.001
	Paralakhemundi	48.2	4.18	3.27	5.34	<0.001
	Berhampur	23.4	0.92	0.75	1.12	0.430
	Bhubaneswar	54.9	5.09	4.11	6.30	<0.001
	Malkangiri	41.3	3.13	2.44	4.01	<0.001
Travel History (Since one month)	No	34.7	Ref.			
	Yes	38.7	0.85	0.65	1.10	0.229
Symptoms in past 30 days	No	34.0	Ref.			
	Yes	44.2	1.20	0.96	1.51	0.100
COVID test result of Participant	Negative	30.3	Ref.			
	Positive	80.0	11.47	8.76	15.01	<0.001
	Not tested	30.6	1.42	1.22	1.66	<0.001
COVID test result of family member	Negative	44.6	Ref.			
	Positive	59.2	1.05	0.73	1.51	0.788
	Not tested	32.0	0.96	0.79	1.16	0.719

Discussion

Our study evaluated the proportion of seropositive individuals from multiple high risk groups working in six urban centres of Odisha during the COVID-19 pandemic from August to November, 2020. This included personnel from health care, police, municipality/sanitation, vendors, residents of containment zones, and prisoners. The overall seropositivity found in our study was 34.9%. The seropositivity varied among the various groups, with the highest seropositivity seen in prisoners, followed by municipality/ sanitation staff, police personnel, and health care workers. Very few studies on seroprevalence of COVID-19 globally have evaluated personnel involved in multiple essential activities during the pandemic [8, 15, 16].

The seropositivity among health care workers in our study varied from 9.6% in Rourkela to 51.7% in Bhubaneswar. Studies from several countries have reported varying proportions of seropositivity against SARS-CoV-2 in health care workers. Two hospitals in Greece reported a low seropositivity of 1.26% and 0.53% during April to May, 2020 [17]. The study used point of care tests/ rapid tests for detection of IgM/IgG antibodies against SARS-CoV-2, which have lower sensitivity than assays such as ECLIA, and hence could be one of the reasons for the low seropositivity seen in this study [17]. Another study among health care workers from Italy in April 2020, which used rapid tests for detection of IgM/IgG, reported a seroprevalence of 14.4% IgM and 7.4% IgG [9]. Other

studies from European countries have reported varying seropositivity from 3% in Finland (March-April, 2020) to 9.6% in Switzerland (April, 2020) [5, 6]. A prospective longitudinal survey among health care workers in Munich, Germany (health care workers tested every 2–6 weeks), during March-July 2020, reported a higher rate of SARS-CoV-2 seroconversion among health care workers working in COVID-19 dedicated wards compared to non-COVID-19 emergency department and non-frontline personnel [3]. A study involving asymptomatic health care workers at a Canadian tertiary care center during April-May, 2020, reported a seropositivity ranging from 1.4–3.4%, depending on the type of assay used [4].

Few studies from Asia and Africa have evaluated seroprevalence against SARS-CoV-2 in high risk groups. A study in a limited number of health care workers (n = 244) at a private health facility in Mumbai, India, during June 2020, found a seropositivity of 4.3% in asymptomatic health care workers and 70% among health care workers who were previously symptomatic but not tested for COVID-19 [14]. A large cross-sectional study involving 12621 health care workers from 85 hospitals across Saudi Arabia in May, 2020, reported an overall seroprevalence of 2.36% [18]. The study demonstrated a significant difference in seropositivity among health care workers working in dedicated COVID-19 referral hospitals compared to non-COVID-19 hospitals (2.9% vs 0.8% respectively) [18]. Another study involving health care and health research personnel from Guinea-Bissau, West Africa, found a 18% seropositivity during November, 2020 [19].

In addition to health care workers, very few studies globally have evaluated the seroprevalence against SARS-CoV-2 in other high risk groups. A study among homeless people in Paris, France, during June-July 2020, reported a high seroprevalence of 52%, and the study demonstrated a significant association between COVID-19 seropositivity and overcrowding [20]. A high seropositivity of 57.9% was reported from an urban slum in south India [21]. Overcrowding is one of the reasons for the high seropositivity observed in prisoners and residents of slums seen in our study. A study among policemen on duty at high risk areas of Lahore, Pakistan, reported a seropositivity of 15.6% (24/154) during May, 2020 [10].

Our study had a few limitations. The number of study participants in each category of high risk group was not uniform due to the restricted availability of participants in certain risk groups such as press staff and prisoners. In our study, we did not evaluate the seropositivity among health care workers separately for those working in COVID-19 dedicated wards/ hospitals and those working in non-COVID-19 essential wards/ hospitals. We also did not evaluate the seroprevalence among high risk groups periodically, which could have helped inform better regarding the increase in the proportion of individuals infected with SARS-CoV-2.

Conclusions

To conclude, our study from six urban centres of Odisha, India, showed that the risk of COVID-19 infection varied among the various high risk groups of Odisha. Periodic seroprevalence studies in future is essential to protect personnel involved in frontline activities during the ongoing pandemic, such as health care workers, police personnel, municipality/ sanitation staff, etc. Periodic serosurveys in overcrowded conditions such as prisons and urban slums can provide crucial information regarding the rate of spread of the disease in these high risk settings.

Abbreviations

Coronavirus disease 2019 (COVID-19)

Electro-chemiluminescence immunoassay (ECLIA)

Real-time PCR (qRT-PCR)

Rapid antigen test (RAT)

Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2)

Declarations

Ethics approval and consent to participate

Approval for the protocol was obtained from the ICMR-RMRC Institutional Human Ethics Committee and the State Health and research ethics committee. Participants who were involved in professional duties in their respective groups since at least the previous 3 months, and who agreed to provide written informed consent for data and sample collection were included in the study. All methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication

All the authors have contributed to, seen, and approved the final, submitted version of the manuscript.

Availability of data and material

Since the study is continuing in some settings, data are still being generated and have not been placed in a public repository. The data analysed during the period reported here will be made available on request after de-identification.

Competing interests:

The authors declare that they have no competing interests.

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Authors' contributions

SP, SKP1, SK designed the study. Data collection and management was done by SK, JSK, SKP1, RPM, SKP2, and DMS. DB, JT, DP, AM, GCD, HRC, SRB, AP, and RKS led the laboratory work. SG, SK, IP performed the data analysis and wrote the manuscript. The manuscript was critically reviewed by SP, SKP1. All authors read and approved the final manuscript.

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Figures

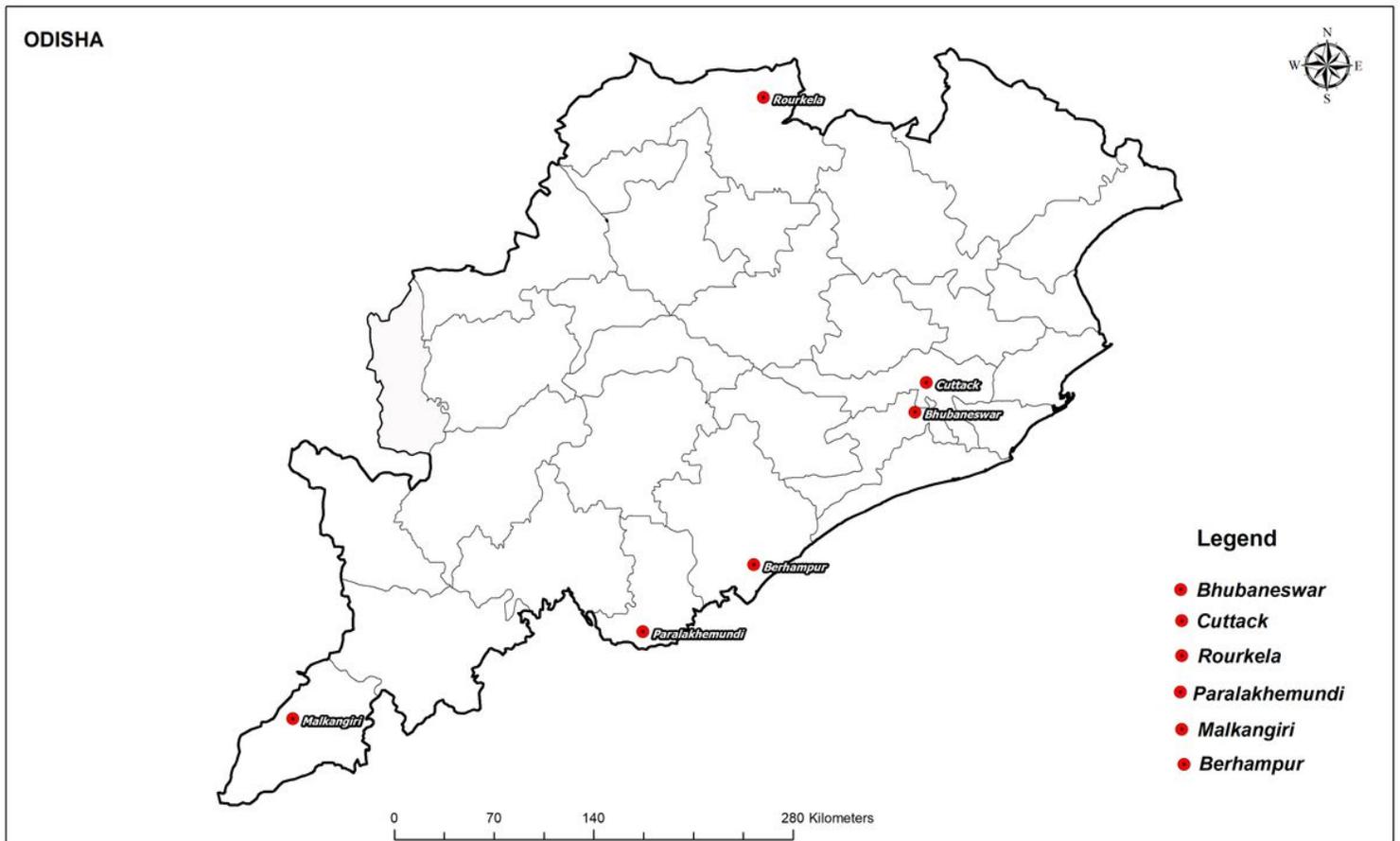


Figure 1

Six urban sites of Odisha included in the sero-survey.

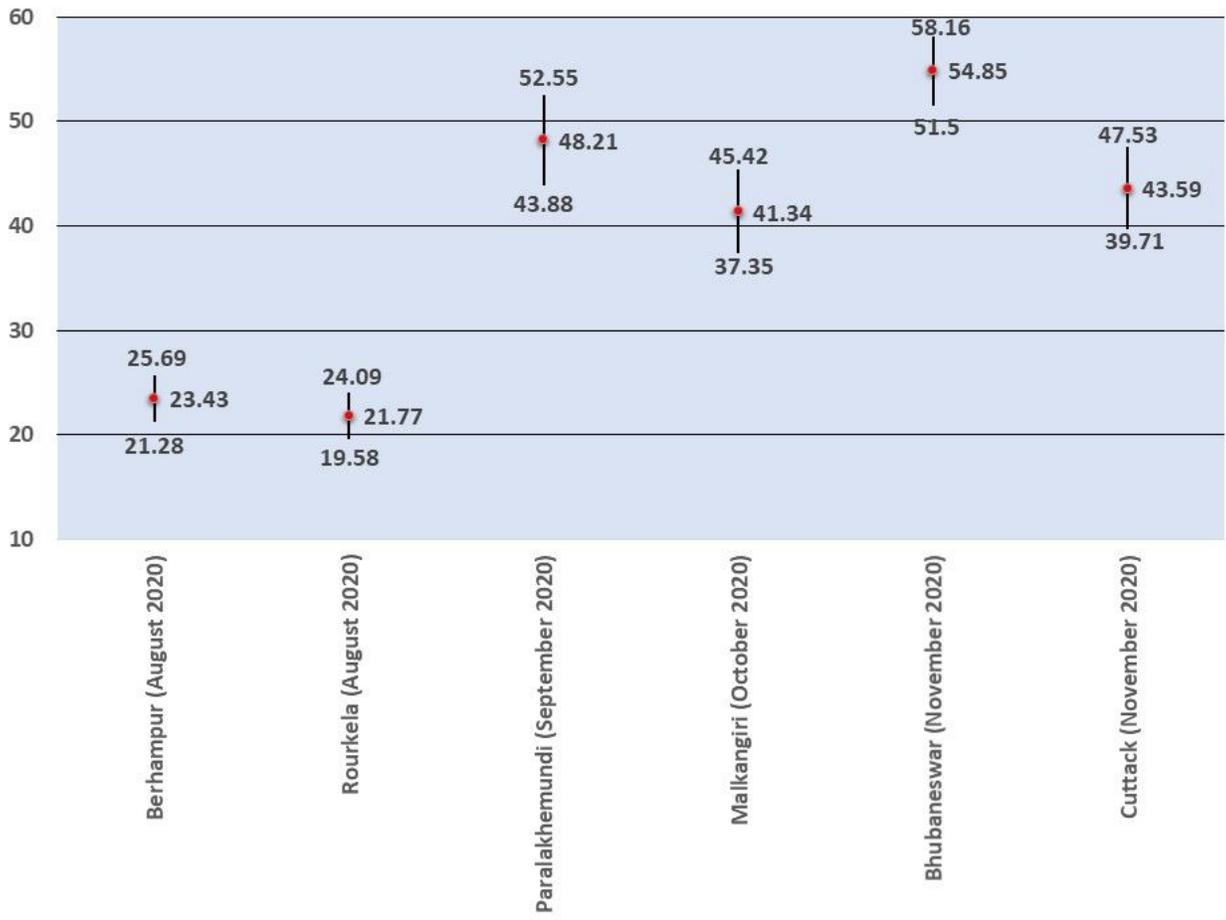


Figure 2

COVID-19 seroprevalence (proportion \pm 95 % CI) across six urban sites of Odisha, 2020