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Coronavirus Pandemic

Serosurveys to detect SARS-CoV-2 antibodies among high-risk groups in six urban cities of Odisha, India

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Abstract

Introduction: Personnel involved in essential services or residing in high-risk areas during the COVID-19 pandemic are at increased risk of getting infected. We evaluated the proportion of personnel infected in several high-risk groups in Odisha using seroprevalence studies.
Methodology: During July to November, 2020, individuals from multiple high-risk groups in 6 urban cities (Bhubaneswar, Berhampur, Cuttack, Malkangiri, Paralakhemundi, and Rourkela) in Odisha, India, were recruited to 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 (Roche Diagnostics, Rotkreuz, Switzerland). Information on socio-demographic variables, association with a confirmed or suspected case, and other details were collected using an electronic data capture tool and analysed with a statistical software.
Results: The overall COVID-19 seroprevalence was 34.9% (95%CI 33.6-36.2) among the 5434 individuals. 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%), followed by municipality/ sanitation staff (43.5%), and other office going staff (40.8%). Multivariate logistic regression indicated that participants aged 18-29 years, 30-44 years, residents of slums and vending zone, municipality staff, prisoners, residents of urban cities Malkangiri, Cuttack, Paralakhemundi, Bhubaneswar and those with previous history of COVID-19 were independent co-relates of seropositivity.
Conclusions: The risk of COVID-19 varied among the high-risk groups of Odisha. Periodic seroprevalence studies in future are essential to protect the high-risk personnel involved in frontline activities during the pandemic.

Key words: antibodies; COVID-19; high-risk groups; Odisha; seroprevalence.

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Introduction

Coronavirus disease 2019 (COVID-19), caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has resulted in more than 579 million cumulative infections globally, with more than 6.4 million deaths as on 8th August, 2022 [1]. In India, as of 8th August 2022, more than 43 million people have been infected with SARS-CoV-2, with approximately 526,000 deaths due to COVID-19 [2]. The high load of COVID-19 patients due to the high transmissibility of SARS-CoV-2 has overwhelmed 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, in which antibody levels against SARS-CoV-2 in the population, 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 to June, 2020, involving 28000 individuals, reported a seroprevalence of 0.73% (95% CI: 0.34-1.13) [11]. Subsequently, the second national serosurvey, conducted during August to 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].

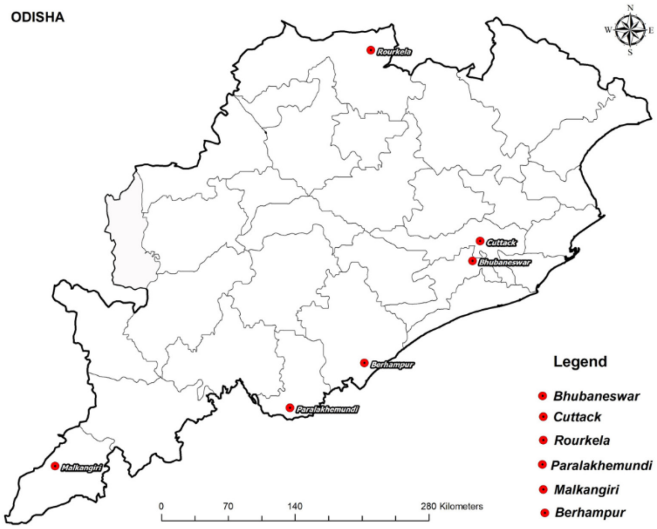
Very few studies from India have evaluated the seroprevalence against SARS-CoV-2 among frontline workers during the pandemic [14]. In this study we have evaluated the seroprevalence against SARS-CoV-2 in multiple high-risk groups, which included health care workers such as medical staff, nursing, hospital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

Methodology

Study design and participants

This was a cross sectional serological survey carried out between July and November, 2020, in six urban cities of the state of Odisha in eastern India. The six cities were Bhubaneswar (capital city of Odisha), Berhampur, Cuttack, Malkangiri, Paralakhemundi, and Rourkela (Figure 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 quota 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.

Figure 1. Six urban cities of Odisha included in the sero-survey.



Data collection

Data was collected using a structured questionnaire on several parameters such as socio-demographic variables including name, gender, occupation, place, etc., association with confirmed or suspected cases of COVID-19 patients, symptoms profile of individuals within 30 days, travel history, and details of previous 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 recommended by the World Health Organization (WHO) 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, 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 1 indicated absence of antibodies in serum and more than or equal to 1 indicated presence of antibodies in serum.

Statistical analysis

The seroprevalence of COVID-19 infection was estimated as the proportion along with 95% confidence intervals (95% CI) and its distribution assessed across cities. Sociodemographic factors such as age group, gender, types of occupation and urban site of residence were presented as frequencies. History of travel, flu like symptoms, status of COVID-19 testing during the previous 30 days were also included in the evaluation

and presented as frequencies. The factors associated with 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, USA).

Results

A total of 5480 participants from the six urban cities of the state were recruited to the study from July to November, 2020. After data scrutiny and rejection of leaked or inadequate samples, 5434 (99.2%) 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 years and 64.2% were males. The maximum number of participants were from Berhampur (26.8%), followed by Rourkela (24.4%).

Table 1. Socio-demographic 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 cities	
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 history 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)
History of COVID-19 infection	
Yes	489 (9.0)
History of COVID-19 disease in family	
Yes	223 (4.1)

More than one third of the survey participants were health care workers (36.4%), followed by police (17%) and municipality staff (13.9%). 11.6% were from either slums or vending zones and 6.3% were residents of containment zones. 5.3% of the participants were prisoners.

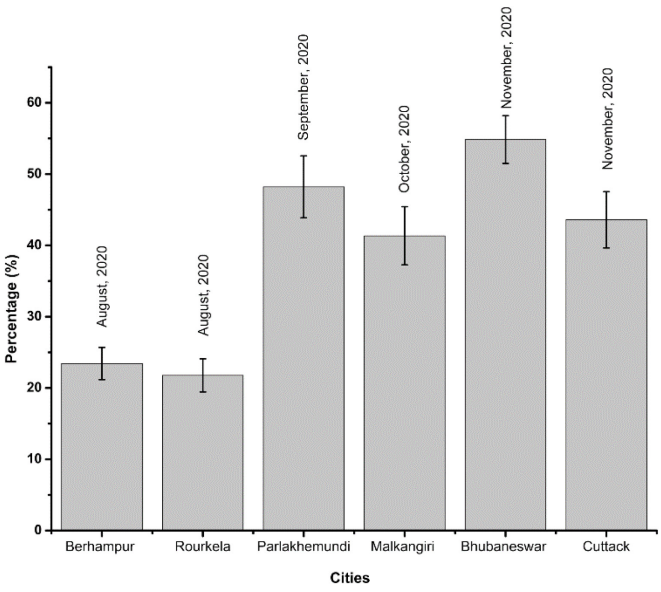
About 9% of participants had flu like symptoms during the previous 30 days. 47.7% study participants had undergone testing for COVID-19 before the survey, and 9% were positive for COVID-19, confirmed either by real-time PCR (qRT-PCR) or by rapid antigen test (RAT). Confirmed cases of COVID-19 infection/disease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

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 (Figure 2).

Seropositivity was maximum among prisoners (47.7%), although it included participants from only Berhampur and Rourkela. This was followed by seropositivity among municipality/ sanitation staff (43.5%), other office going staff (40.8%), slum residents and vendors (39.8%), police personnel (38.3%), health care workers (27.1%), press staff (27.2%) and residents of containment zones (25.2%).

Among the health care workers, maximum seropositivity was observed in the capital city,

Figure 2. COVID-19 seroprevalence (proportion ± 95 % CI) across six urban cities of Odisha, 2020.



Bhubaneswar (51.7%), followed by Parlakhemundi (49.3%), Cuttack (42.5%), and Malkangiri (37.8%). Among police personnel, the maximum proportion of seropositive individuals was found in Malkangiri (58.9%), followed by Parlakhemundi (54%), Bhubaneswar (52.3%) and Cuttack (45.1%). The seropositivity among municipality/sanitation staff ranged from 27.8% in Berhampur to 58.6% in Bhubaneswar. The seropositivity among prisoners was highest in Rourkela (67%), followed by Berhampur (40%) (Table 2).

On multivariate logistic regression, participants aged 18-29 years and 30-44 years had 1.4 times and 1.5 times more odds of possessing antibody against SARS-COV-2 than the reference age group. Residents of slums and vending zones had 2.8 times, municipality staffs had 1.7 times and prisoners had 4.4 times higher odds of having SARS-COV-2 antibody. Those with previous history of confirmed COVID-19 were 11.4 times more likely to possess SARS-COV-2 antibody (Table 3).

Discussion

Our study evaluated the proportion of seropositive individuals in multiple high-risk groups working in six urban centres of Odisha during the COVID-19 pandemic from July 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 in 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/ rapids 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% to 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 on 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

Table 2. COVID-19 seroprevalence in high-risk groups across six urban cities of Odisha, July-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)	N	% (95% CI)
Health care workers	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	27.1 (25.1-29.1)
Police staff	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)	354/922	38.3 (35.2-41.6)
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)	330/758	43.5 (39.9-47.1)
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)	183/448	40.8 (36.2-45.5)
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)		-	252/633	39.8 (35.9-43.7)
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)				-	86/341	25.2 (20.6-30.1)
Prisoners	83/207	40.0 (33.3 - 47.1)	55/82	67.0 (55.8 - 77)		-		-				-	138/289	47.7 (41.8-53.6)
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)	18/66	27.2 (17.0-39.6)
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)	1897/5434	34.9 (33.6-36.2)

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 could be 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 in 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. The sensitivity of the method for analyzing sera relative to the dominant strains may underestimate the overall prevalence as it uses several antigens and an

Table 3. Co-relates of COVID-19 seropositivity among high-risk group population across six urban cities of Odisha, India 2020 (n = 5434).

Variables	Sero-prevalence (%)	Adjusted odds ratio (AOR)	95% C.I.		*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	0.84	1.65	0.324
≥ 60 years	27.2	Ref.			
Gender					
Female	33.0	Ref.			Ref.
Male	36.0	0.91	0.79	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
Prisoners	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 (In the last 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

algorithm which may fail to detect dominant/emerging strains of SARS-CoV-2. 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. Lastly, seroprevalence is based on immune responses associated to an occurrence of past infections. However, the antibodies do wane and may not accurately reflect the current epidemiology.

Conclusions

Our study from six urban centres in Odisha, India, showed that the risk of COVID-19 infection varied among the various high-risk groups. Periodic seroprevalence studies in future is essential to understand the burden of COVID-19 infection and protect personnel involved in frontline activities during the ongoing pandemic, such as health care workers, police personnel, municipality/sanitation staff, etc. Even though many high-risk individuals had developed antibodies against SARS-CoV-2, those individuals who were sero-negative must be vaccinated to be safe from COVID-19. 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.

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Ethics and consent to participate

The participants who were involved in professional duties in their respective groups for 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 privacy of the participants. Approval for the protocol was obtained from the Institutional Human Ethics Committee of ICMR-RMRC, Bhubaneswar and the State Health and research ethics committee.

Authors' contributions

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

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