



Seroprevalence of SARS-CoV-2 infection among frontline police personnel in Mumbai, India

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Abstract

Introduction A serosurvey was designed to ascertain the extent of infection among police personnel in Mumbai, India, during the last week of January 2021, at the end of the first wave of the COVID-19 pandemic, and just before the introduction of vaccination.

Methods The survey was carried out to screen for SARS-CoV-2 among 3232 police personnel. Of the 3176 participants willing for blood sample collection, 3077 personnel were found to be eligible for testing antibodies against the SARS-CoV-2 virus using the Roche Diagnostics' Elecsys Anti-SARS-CoV-2 assay.

Results The overall seroprevalence was 74.1% (95% CI 72.5–75.6). Males (75.1%, 73.4–76.8) had significantly higher seroprevalence than females (69.8%, 66.0–73.3), 18–39 years age group (76.4%, 74.4–78.3) than 40–59 years age group (70.6%, 67.9–73.1), non-officers (75.2%, 73.5–76.7) than officers (63.8%, 58.2–69.0), and personnel without comorbidities (75.0%, 73.3–76.6) than with comorbidities (69.7%, 65.6–73.5). Additionally, personnel with resident members positive for COVID-19 (89.6%, 84.7–93.1), personnel having reported COVID-19 earlier (95.5%, 93.8–96.7), and personnel having PCR positivity earlier (96.4%, 94.7–97.6) had significantly higher seroprevalences than others. All other variables, including diabetes and blood glucose status, lipid levels and thyroid enzymes, were not significantly associated with the seroprevalence levels.

Conclusions Almost three-fourths of frontline police personnel had evidence of past COVID-19 infection at the end of the first wave in January 2021, just before the introduction of COVID-19 vaccination. These frontline non-healthcare essential workers are an important risk group, and amenable to rapid serosurveys. These findings may help in estimating transmission status in the general community, along with disease burden, aiding prioritization of healthcare services.

Keywords Seroprevalence · Elecsys Anti-SARS-CoV-2 assay · COVID-19 · Police personnel

Introduction

As the world grapples with the impact of COVID-19, and its recurrent waves, frontline workers are the most vulnerable

to infection [1–3]. As healthcare workers, police personnel have been at the absolute frontline of the COVID-19 response. In addition to their regular duties which continue unabated, and cannot be delegated to work-from-home, police personnel have been responsible for enforcement of lockdowns, social distancing, and compliance with COVID appropriate behavior (CAB). During the overwhelming second wave in India, it was commonplace to see policemen helping the sick reach hospitals and respond appropriately.

In India, reverse transcription polymerase chain reaction (RT-PCR) testing has been offered mostly for symptomatic individuals. Therefore, any estimates of disease prevalence, if dependent on PCR reports alone will underestimate the true prevalence. This is even more so since the majority of patients with COVID-19 are asymptomatic.

Therefore, to ascertain the prevalence of COVID-19 infection in this vulnerable demographic, a seroprevalence

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study to assess antibodies against SARS-CoV-2 was conducted among police personnel in Mumbai, India.

Table 1 Baseline characteristics of study participants

Characteristics	Number (n = 3232)	%	95% CI (Lower limit)	95% CI (Upper limit)
Gender				
Females	630	19.5	18.2	20.9
Males	2602	80.5	79.1	81.8
Age group (Years)				
18–39	1971	61.0	59.6	63.0
40–59	1251	38.7	36.6	40.0
Official rank				
Officers	304	9.4	8.5	10.5
Non-officers	2928	90.6	89.5	91.6
Education				
Non graduate	1746	54.0	52.3	55.7
Graduate	1392	43.1	41.4	44.8
Post Graduate	94	2.9	2.4	3.6
Residence status				
Alone	261	8.1	7.2	9.1
Colleagues	96	3.0	2.4	3.6
Family	2309	71.4	69.9	73.0
Friends	566	17.5	16.2	18.9
Posted in a COVID hotspot for duty				
No	993	30.7	29.2	32.3
Yes	2239	69.3	67.7	70.8
Medical comorbid condition/s				
No	2696	83.4	82.1	84.7
Yes	536	16.6	15.3	17.9
COVID-19 antibody testing status				
Not done	2017	62.4	60.7	64.1
Negative	849	26.3	24.8	27.8
Positive	366	11.3	10.3	12.5
Any resident member had COVID-19				
No	3013	93.2	92.3	94.0
Yes	219	6.8	6.0	7.7
Any colleague had COVID-19				
No	2582	79.9	78.5	81.2
Yes	650	20.1	18.8	21.5
COVID-19 diagnosed earlier				
No	2382	73.7	72.2	75.2
Yes	850	26.3	24.8	27.8
Treated at home	62	1.9	1.5	2.5
Care Centre	333	10.3	9.3	11.4
Designated Hospital	442	13.7	12.5	14.9
Intensive Care Unit	9	0.3	0.2	0.5

Materials and methods

This cross-sectional serosurvey was carried out along with a questionnaire-based study designed to assess knowledge, attitudes and practices (KAP) of COVID-19, along with diabetes, thyroid, lipid profile and eye screening programme. The study was carried out during the last week of January 2021, at the end of the first wave of the COVID-19 pandemic, and just before the introduction of vaccination. Study subjects included police officers and non-officer personnel in Mumbai, the capital of Maharashtra, India.

The frontline police personnel from across Mumbai participated in the serosurvey, at Naigaon, one of Mumbai's largest police centres. Police personnel posted at known COVID-19 hotspots, COVID hospitals and other high-risk areas were invited to participate in the serosurvey. Participation was voluntary and following consent.

A total of 3232 police personnel volunteered for the survey. Among 3176 personnel approached for serosurvey, 3077 participants consented and provided blood samples for antibody testing for detection of antibodies against SARS-CoV-2. Each of these underwent a blood test to ascertain the presence of SARS-CoV-2 antibodies.

The Roche Diagnostics' Elecsys Anti-SARS-CoV-2 assay is an automated immunoassay intended for the qualitative detection of antibodies to SARS-CoV-2. It has a specificity of 99.8% specificity and a sensitivity of 100% if performed 14 days post-PCR confirmation (Roche Diagnostics, Rotkreuz, Switzerland). It is a double-antigen sandwich electrochemiluminescence immunoassay for the determination of total antibodies against SARS-CoV-2, without distinguishing between IgG, IgM, and IgA. The results are interpreted as reactive or positive when the Cut-off index (COI), is equal to, or more than equal to 1.0, and as non-reactive or negative when the COI is less than 1.0.

In addition, the data analysed from the larger KAP study and metabolic screening included the following aspects - basic demographics, medical history, test for the presence of antibodies against SARS-CoV-2. If yes, we enquired the results of the test, the presence of a COVID-19 positive case in their family or workplace and COVID-19 earlier, along with the RT-PCR results, whenever available.

The study protocol was approved by the Independent Ethics Committee at Ashwini Rural Medical College, Hospital and Research Centre, Solapur, Maharashtra. The inclusion criteria for the study were voluntary participation and limited to the police personnel > 18 years.

Statistical analyses

Frequency and percentages were calculated for categorical variables. The χ^2 tests with Yates' correction or the Fishers' exact test were used to examine the difference in proportion. A P-value of <0.05 was considered statistically significant. The overall and risk-group specific seroprevalences were reported with 95% confidence intervals using OpenEpi (Open Source Epidemiologic Statistics for Public Health). Additionally, seroprevalences were reported as per demographics, comorbidities, work-related risk/exposures, symptomatic and PCR-confirmed subset with the duration from confirmation.

Results

Baseline characteristics of survey participants

The study was conducted on Police personnel in Mumbai City, from 22 January to 2 February 2021. Among 3232 study participants completing the KAP survey (being reported separately), 3176 participants consented to antibody testing for detection of antibodies against SARS-CoV-2, however, 3077 personnel were available for serological testing. The response rate was 96.9%.

The participants for the survey ($n=3077$) included predominantly males (2602, 80.5%). The age group distribution had the majority of them (61.0%) in the 18–39 age group, followed by 40–59 (38.7%). The majority were

non-officer cadre personnel (90.6%) and officers were 9.4%. Among them, 54.0% were non-graduates. Most (71.4%) were living with their family, and 69.3% of personnel were posted and worked in COVID-19 hotspots for duty. Only 16.6% reported having known underlying medical conditions (Table 1), 12% of them reported having a single underlying medical condition and 4.6% reported having multiple underlying medical conditions. Hypertension was the leading underlying condition (9.2%) followed by diabetes (8.2%). Most (76.1%) personnel had never been tested for diabetes. The baseline characteristics of the serosurvey population have also been delineated in Table 2 for the personnel available for antibody testing for the representativeness with the overall survey population.

The findings reported in Table 1 help us to understand the burden of disease on the healthcare services required. Overall, 46.5% were either treated at home or the COVID care center due to the mild nature of the illness. Hospital care was required in only 14% of those diagnosed with COVID-19. Although 53.1% required hospitalization, this was probably because of the hospital isolation mandate, rather than for the management of illness, as intensive care was required for only 1.1% of COVID-19 cases.

Seroprevalence with associated variables

In all, 62.4% had never been tested for the prevalence of antibodies against SARS-CoV-2 earlier (Table 1); while 30.1% of 1215 participants who had been tested for the presence of antibodies earlier were reported positive for

Table 2 Seroprevalence estimates of SARS-CoV-2 antibodies along with the associated variables

Characteristics	Tested (N)	Tested (%)	Positive (n)	Seroprevalence (%)	Seroprevalence (95% CI)	p-value
Gender	3077	100.0	2279	74.1	72.5, 75.6	NA
Females	599	19.5	418	69.8	66.0, 73.3	<0.010
Males	2478	80.5	1861	75.1	73.4, 76.8	
Age group (years)						
18–39	1854	60.3	1417	76.4	74.4, 78.3	<0.001
40–59	1209	39.3	853	70.6	67.9, 73.1	
Official rank						
Officers	298	9.7	190	63.8	58.2, 69.0	<0.001
Non-officers	2779	90.3	2089	75.2	73.5, 76.7	
Medical comorbid condition/s						
No	2549	82.8	1911	75.0	73.3, 76.6	<0.005
Yes	528	17.2	368	69.7	65.6, 73.5	
Any resident member had COVID-19						
No	2866	93.1	2090	72.9	71.3, 74.5	<0.001
Yes	211	6.9	189	89.6	84.7, 93.1	
COVID-19 diagnosed earlier						
No	2258	73.4	1497	66.3	64.3, 68.2	<0.001
Yes	819	26.6	782	95.5	93.8, 96.7	
COVID-19 RT PCR result earlier						
Negative	1552	50.4	1048	67.5	65.2, 69.8	<0.001
Positive	643	20.9	620	96.4	94.7, 97.6	

SARS-CoV-2 antibody. Only 6.8% reported that they had a resident family member diagnosed as COVID-19 earlier. Also, 20.1% reported that they had a colleague who was diagnosed as COVID-19 previously. Overall, 26.3% of participants reported diagnosis of COVID-19 earlier. Also, 2308 (71.4%) participants had already been tested for RT-PCR, with 669 (28.9%) reported positive by RT-PCR (Table 1).

Antibody response to SARS-CoV-2

The overall seroprevalence was 74.1% (95% confidence interval (C.I.); 72.5–75.6%) among 3077 participants. Males (75.1%, C.I. 73.4–76.8) had significantly higher ($p < 0.001$) seroprevalence than females (69.8%, C.I. 66.0–73.3). Higher seroprevalence was reported in 18–39 age group (76.4%, C.I. 74.4–78.3) than 40–59 age group (70.6%, 67.9–73.1) ($p < 0.001$). The officers had lower seroprevalence (63.8%, 58.2–69.0, $p < 0.001$) as compared to non-officers (75.2%, 73.5–76.7). The personnel reporting medical comorbid condition had lower seroprevalence (69.7%, 65.6–73.5, $p < 0.005$) as compared to those without comorbidity (75.0%, 73.3–76.6). The personnel with resident member positive for COVID-19 had higher seroprevalence (89.6%, 84.7–93.1, $p < 0.001$) than those without resident member reporting COVID (72.9%, 71.3–74.5, $p < 0.001$). The personnel having reported COVID-19 earlier had higher seropositivity (95.5%, 93.8–96.7, $p < 0.001$) than those who did not report COVID-19 earlier (66.3%, 64.3–68.2, $p < 0.001$). Similarly, those personnel having RT-PCR positivity earlier had higher seropositivity (96.4%, 94.7–97.6, $p < 0.001$) as compared to those negative (67.5%, 65.2–69.8) (Table 2).

All other variables including investigations for diabetes screening, lipid profile and thyroid were not significantly associated with seropositivity. Having diabetic or pre-diabetic conditions also did not affect, the risk of acquiring infection.

Discussion

It has been shown that health care workers, domestic housekeepers, and police officers were the leading high-risk occupations [1]. In addition to their regular duties, policemen have been responsible for enforcement of curfews and lockdowns, social distancing, and compliance on mask use. The police have also been responsible for the enforcement of CAB. Therefore, such studies in police personnel are necessary and important [2,3].

As per information provided by Mumbai Police, on March 22, 2021, there were 155 active cases of COVID-19 and 100 deaths in the police force. There were 7,449 police

personnel reported positive and most of them have recovered. A total of 2,544 police officers and 27,233 policemen have been given the first dose of the vaccine following the study. In these 1,126 officers and 14,511 have been given the second dose of the vaccine, by March 2021, indicating vaccine acceptance [2], which is in line with our KAP study findings of very good willingness for vaccine acceptance (75%) [3]. At the time of conduct of the present study, there were no reports of seroprevalence studies in India and globally, before the introduction of vaccination among frontline non-healthcare essential workers. We thought it appropriate and timely to undertake a seroprevalence study in Police personnel in Mumbai, who experienced the major brunt during the raging pandemic. A few seroprevalence studies in health care workers in Mumbai have been reported [4,5].

The present study was conducted in the last week of January 2021 in over 3000 participants, with a response rate of over 95%. The gender, age, official rank and educational status of the surveyed population was representative of the police personnel in Mumbai. Almost 1/6th of the police personnel reported having underlying comorbid conditions. Almost 1/4th of the Police personnel had reported having been diagnosed as COVID-19 before the survey (Table 1). Also, only one in 100 COVID cases required intensive care, indicating mostly mild illness which could be managed at home or COVID care centres.

The overall seroprevalence reported during the present study is over 70%. The seroprevalence differed based on the gender and age composition of the surveyed population, timeliness about the transmission level and compliance with CAB. This is the first report of seroprevalence studies of COVID-19 in police personnel in India. There are very few studies in police personnel globally, in which various levels of seroprevalence have been reported [6–8]. In Pakistan, a study among 154 policemen in the last week of May 2020, reported 15.6% seropositivity for IgG antibodies with all of them being asymptomatic, of which only 10% had reported exposure to confirmed cases [6]. A serological survey in public service agency in New York, USA reported seropositivity of 22.5% during May to July 2020 [7]. However, seroprevalence of 33.6% was reported in 1592 military workers in Southern Brazil in July 2020. Our study reports higher seropositivity as compared with the above-mentioned studies, which could be due to different time periods of implementation of the surveys. A recent study among Police officer cohort from Bern, Switzerland, undertaken in February–March 2021, among 978 Police personnel reported a low seroprevalence of 12.9%. However, the authors concluded that seroprevalence among Police officers was comparable to the general population and the risk of transmission through house-hold contact. These differences could be due to different levels of local transmission [9].

Seroprevalence of SARS-CoV-2 was low among the adult population in India around the beginning of May 2020 [10]. To consider in planning seroprevalence studies during influenza A H1N1 2009 pandemic, timeliness was identified as an important aspect that would help understand the overall transmission status in risk groups and the general population [11].

The significantly higher seroprevalence in males than females could be because males are more exposed due to outdoor duties than females and females probably are more careful than males in adhering to CAB. Bwire et al., found females to be more resistant to infections, possibly influenced by various factors including sex hormones and high expression of angiotensin-converting enzyme 2 (ACE 2) SARS-CoV-2 receptors in men. Higher levels of smoking and drinking among men may make them more vulnerable [12]. The smaller sample size of females may also be a confounding factor. Higher seroprevalence in the 18–39 age group was observed which could be because older age people are more cautious, keep themselves updated with the knowledge, take stringent precautions due to risk of having the severe disease with an underlying medical condition, proven as the important risk factor [13,14]. The lower seroprevalence in officers as compared to non-officers could be due to the work profile, and their direct public contact is limited, thereby limiting exposure. Their higher educational level may have influenced their CAB, resulting in fewer chances of infection. The lower seroprevalence in personnel reporting medical co-morbid conditions as compared to those without comorbidity could be due to adherence to CABs [14].

Higher seropositivity in a colleague of police personnel positive for COVID-19 could be explained based on their engagement in duties at hospitals and public places. The higher seropositivity in personnel with resident members positive for COVID-19 could be due to the exposure to SARS-CoV-2 and indicates higher transmission of SARS-CoV-2 in the family settings. The higher seropositivity in personnel having reported COVID-19 earlier and RT-PCR positive individuals probably indicate the higher levels of specific antibodies with persistence over longer periods thereby giving higher seroprevalence.

Although we offered sugar and lipid profile testing simultaneously, we could not attempt to study their association with seroprevalence. Systematic associations of COVID-19 and related metabolic abnormalities may need to be investigated further.

In conclusion, the overall seroprevalence of 74.1% reported in Police personnel in Mumbai at the end of the first wave indicates a higher risk of infection among front-line workers. Studies in such at-risk populations would be

helpful to understand community transmission and disease burden, thereby providing the evidence needed for response.

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Author contributions Conception and design of the study: NK, BVT, SDP, SB; Field and Laboratory work: NK, SB; Acquisition, analysis and interpretation of data: BVT, SDP, NK, SB; Wrote and approved the manuscript: SB, BVT, SDP, NK.

Declarations

Conflict of interest None.

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