Monitoring the trend of SARS-CoV-2 seroprevalence in Chennai, India, July and October 2020

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Background: The first serosurvey conducted in Chennai, India in July 2020 reported sudden acute respiratory syndrome coronavirus 2 (SARS-CoV-2) prevalence of 18.4%. The aim of this study was to estimate the seroprevalence in the month of October 2020.

Methods: We conducted a survey in 153 streets covering 51 wards and all 15 zones of the city and enrolled from each street 40 individuals ≥10 y of age. We collected 3–5 ml of venous blood and tested for anti-nucleocapsid (N) immunoglobulin (IgG) antibodies using a SARS-CoV-2 IgG assay. We estimated the weighted seroprevalence of SARS-CoV-2 infection and adjusted for test characteristics.

Results: Of the 6366 sera tested, 2052 were positive for anti-N IgG antibodies. The weighted seroprevalence after adjusting for test characteristics was 30.1% (95% confidence interval [CI] 24.7 to 36.1). There was wide variation in the seroprevalence between wards, ranging from 11.0% (95% CI 5.6 to 16.4) to 48.1% (95% CI 39.5 to 56.7).

Conclusions: The seroprevalence of SARS-CoV-2 infection in Chennai nearly doubled between July and October 2020.

Introduction

India had reported >8 million coronavirus disease 2019 (COVID-19) cases by October 2020. During the initial months of the pandemic, most reported COVID-19 cases were from urban areas. However, very few published reports are available about the seroprevalence of infection from megacities.[1]

The state of Tamil Nadu reported the first case in Chennai (the capital city) on 5 March 2020. During the early phase, most cases were reported from Chennai and surrounding coastal districts. Chennai was under lockdown beginning on 25 March, which was relaxed in a phased manner starting on 4 May. We conducted the first round of surveys in July 2020, covering 51 of the 200 wards spread across all 15 zones. Of the 12 405 sera tested for immunoglobulin G (IgG) antibodies against nucleocapsid (N) protein in July, 2673 were positive, with a weighted seroprevalence of 18.4% (95% confidence interval [CI] 14.8 to 22.6).[2] We conducted the second round of survey in October 2020 to monitor the seroprevalence trend in the Chennai.

Methods

Of the 200 wards (subdivisions of an urban area) in Chennai, 51 were selected randomly by the probability proportion to population size method for the first survey. We repeated the serosurvey in the same 51 wards between 8 and 15 October. In each ward we randomly selected three streets and enrolled 40 individuals ≥10 y of age from each street. We required a minimum sample size of 5401 individuals (rounded to 6000) (see the Supplementary Appendix). The institutional ethics committees of the Indian Council of Medical Research (ICMR)-National

Table 1. Proportion of individuals with IgG antibodies against SARS-CoV-2 by various factors, Greater Chennai Corporation, October 2020

Factors	Tested, n	Positive, n	Unweighted cluster adjusted seroprevalence, % (95% CI)	Weighted seroprevalence, % (95% CI)	Test performance adjusted seroprevalence, % (95% CI)
Overall	6366	2052	32.2 (30.3 to 34.3)	30.4 (25.0 to 36.4)	30.1 (24.7 to 36.1)
Sex					
Male	3338	1006	30.1 (28.1 to 32.2)	29.9 (24.5 to 36.0)	29.6 (24.2 to 35.7)
Female	3021	1044	34.6 (31.9 to 37.3)	30.9 (25.3 to 37.1)	30.6 (25.0 to 36.8)
Others	7	2	28.6 (8.7 to 62.7)	–	–
Age (years)					
10–19	670	220	32.8 (29.3 to 36.5)	25.7 (20.0 to 32.2)	25.4 (19.7 to 31.9)
20–29	1341	416	31.0 (28.6 to 33.6)	29.2 (23.5 to 35.7)	28.9 (23.2 to 35.4)
30–39	1334	436	32.7 (30.2 to 35.3)	32.3 (26.2 to 39.1)	32.0 (25.9 to 38.9)
40–49	1171	393	33.6 (30.9 to 36.3)	33.8 (27.5 to 40.7)	33.5 (27.2 to 40.5)
50–59	933	304	32.6 (29.6 to 35.7)	31.1 (24.8 to 38.2)	30.8 (24.5 to 38.0)
≥60	917	283	30.9 (27.9 to 34.0)	27.5 (21.6 to 34.2)	27.2 (21.3 to 33.9)
History of respiratory symptoms					
Present	263	169	64.3 (55.2 to 72.4)	63.8 (54.2 to 72.4)	63.7 (54.0 to 72.3)
Absent	6103	1883	30.9 (28.9 to 32.9)	29.0 (24.1 to 34.6)	28.7 (23.8 to 34.3)
History of COVID contact					
Yes	175	77	44.0 (34.4 to 54.1)	36.1 (26.3 to 47.2)	35.8 (26.0 to 47.0)
No	5938	1890	31.8 (29.8 to 33.9)	29.7 (24.6 to 35.3)	29.4 (24.3 to 35.0)
Don't know	205	73	35.6 (26.7 to 45.7)	45.3 (35.8 to 55.1)	45.1 (35.5 to 54.9)
History of ever tested for COVID-19					
Yes	810	356	44.0 (37.9 to 50.2)	41.7 (34.2 to 49.6)	41.5 (33.9 to 49.4)
No	5508	1684	30.6 (28.6 to 32.6)	28.7 (23.3 to 34.7)	28.4 (23.0 to 34.4)
COVID-19 test results (N=810)					
Positive	166	135	81.3 (73.1 to 87.5)	81.5 (72.2 to 88.2)	81.4 (72.1 to 88.2)
Negative	624	216	34.6 (29.4 to 40.2)	32.2 (25.4 to 39.8)	31.9 (25.1 to 39.6)
Don't know	20	5	25.0 (9.9 to 50.4)	17.3 (4.1 to 50.6)	17.0 (3.7 to 50.4)

Institute of Epidemiology and ICMR-National Institute for Research in Tuberculosis approved the study protocol. Written informed consent from people ≥18 y of age and parental consent and assent for children 10–17 y of age was obtained. We collected data about sociodemographic details, exposure to laboratory-confirmed COVID-19, history of symptoms suggestive of COVID-19 and COVID-19 testing details using Open Data Kit and 3–5 ml of venous blood from each participant.

All sera were tested for anti-N IgG antibodies (Abbott Laboratories, Abbott Park, IL, USA; sensitivity 100%, specificity 99.6%).[3] We estimated the seroprevalence of sudden acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection along with 95% confidence intervals (CIs) using appropriate sampling weights and adjusting for assay characteristics (see Supplementary Appendix). We did sensitivity analysis using different sensitivities and specificities for the anti-N assay reported by external evaluation.

Results

Of the 8452 residents ≥10 y of age in the visited households, 6645 (78.6%) were available at the time of the survey and 6366 (95.8%) consented to participate (Supplementary AppendixTable A1). The mean age of the study participants was 39.8 y (standard deviation 16.5) (Supplementary Appendix Table A2) and 47.5% were females. The characteristics of those who participated and those who were not available for or refused the survey were comparable by sex. However, we noticed a significant difference by age due to lower participation among individuals in the 10–19 y age group (Supplementary Appendix Table A3). A total of 810 (12.8%) individuals self-reported testing by reverse transcription polymerase chain reaction (RT-PCR) for COVID-19 in the past and 166 (20.5%) self-reported being positive (Table 1).

Of the 6366 sera tested, 2052 were positive for anti-N IgG antibodies. The weighted seroprevalence after adjusting for the test sensitivity and specificity reported by the manufacturer was 30.1% (95% CI 24.7 to 36.1) (Table 1). The results of the sensitivity analysis of overall seroprevalence using sensitivity and specificity reported by external evaluations and the proportion of RT-PCR-positive individuals who tested seropositive is given Supplementary Appendix Table A4. Seroprevalence did not differ by age or sex. Seroprevalence was higher among those reporting a history of respiratory symptoms (63.7%) and positive for RT-PCR (81.4%) (Table 1). For every COVID-19 case

reported, there were 14–15 infections (Supplementary Appendix Table A5).

There was wide variation in the seroprevalence between wards, ranging from 10.6% (95% CI 5.2 to 16.1) to 47.9% (95% CI 39.2 to 56.5). Of the 51 wards surveyed in the two rounds, the seroprevalence increased in 38 and decreased in 13 wards. All 13 wards where the seroprevalence declined except one (Ward 111, Roypettah) had a seroprevalence >30% in July 2020. The four wards that showed a >10% decrease in seroprevalence all had a seroprevalence >40% in July (Supplementary Appendix Tables A6 and A7, Figure A1).

Discussion

The survey findings indicated about one-third of the Chennai population had been previously exposed to SARS-CoV-2 infection. The seroprevalence increased from 18.4% to 30% during the period July–October 2020. During the first serosurvey, the prevalence was higher in the northern and adjoining parts of central Chennai. Subsequently the prevalence increased in most of the wards in central and southern Chennai.

In four wards the seroprevalence declined by 10–20% (Supplementary Appendix Table A7). These wards are located in northern Chennai, with a high population density and more slums. Northern Chennai was affected first by the COVID-19 pandemic. The decrease in seroprevalence could be due to a decline in antibodies over time.[4] The central region is the commercial centre and the southern region is the home to many information technology industries. These regions were spared in the early phase of the pandemic, possibly due to relatively lower population density and better housing conditions.[5]

Despite school closures since March 2020, the prevalence among adolescents was found to be similar to that of young adults. Serosurveys conducted in various cities during June–September 2020 reported prevalences ranging from 4.9% in Puducherry (August) to 57.8% in the slums of Mumbai.

Our study had certain limitations. We did not collect blood samples from children <10 y of age. About one-fourth of eligible individuals from the visited households did not participate in the survey. Participation was considerably lower among children aged 10–19 y, as they were engaged in online classes or parents refused to provide permission. IgG antibodies to N protein declines faster than other antibodies, hence the seroprevalence and infection:case ratio reported could be an underestimate.

In conclusion, the seroprevalence of SARS-CoV-2 infection in Chennai nearly doubled between July and October 2020. The increase was mainly due to an increase in seroprevalence in the central and southern regions after lifting of lockdown restrictions. Continuing adherence to COVID-appropriate behaviours and implementation of containment measures are required. Future serosurveys in the same geographical area may be useful to determine the trends in prevalence and monitor the effects of various COVID-19 control strategies implemented in Chennai.

Supplementary data

Supplementary data are available at *Transactions* online.

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References

1 Malani A, Shah D, Kang G, et al. Seroprevalence of SARS-CoV-2 in slums versus non-slums in Mumbai, India. Lancet Glob Health. 2021;9(2):e110–1.

2 Selvaraju S, Santhosh Kumar M, Vivian Thangaraj JW, et al. Population-based serosurvey for severe acute respiratory syndrome coronavirus 2 transmission, India. Emerg Infect Dis. 2021;27(2):586–9.

3 Bryan A, Pepper G, Wener MH, et al. Performance characteristics of the Abbott Architect SARS-CoV-2 IgG assay and seroprevalence in Boise, Idaho. J Clin Microbiol. 2020;58(8):e00941–20.

4 Ripperger TJ, Uhrlaub JL, Watanabe M, et al. Orthogonal SARS-CoV-2 serological assays enable surveillance of low prevalence communities and reveal durable humoral immunity. Immunity. 2020;53(5):925–33.e4.

5 Das A, Ghosh S, Das K, et al. Modeling the effect of area deprivation on COVID-19 incidences: a study of Chennai megacity, India. Public Health. 2020;185:266–9.