About the Author

Ms. Mai is vice-head of the virology department of the Pasteur Institute in Nha Trang City, Vietnam. She has been part of a team responsible for COVID-19 diagnostics in an area of central Vietnam with a population of ≈25 million people.

References

1. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al.; for the China Novel Coronavirus Investigating and Research Team. A novel coronavirus from patients with pneumonia in China, 2019. N Engl J Med. 2020;382:727–33. https://doi.org/10.1056/NEJMoa2001017
2. Chen SY, Lee YL, Lin YC, Lee NY, Liao CH, Hung YP, et al. Multicenter evaluation of two chemiluminescence and three lateral flow immunoassays for the diagnosis of COVID-19 and assessment of antibody dynamic responses to SARS-CoV-2 in Taiwan. Emerg Microbes Infect. 2020;9:2157–68. https://doi.org/10.1080/22221751.2020.1825016
3. Tan CW, Chia WN, Qin X, Liu P, Chen MI, Tiu C, et al. A SARS-CoV-2 surrogate virus neutralization test based on antibody-mediated blockage of ACE2-spike protein-protein interaction. Nat Biotechnol. 2020;38:1073–8. https://doi.org/10.1038/s41587-020-0631-z
4. Perera RAPM, Ko R, Tsang OTY, Hui DSC, Kwan MYM, Brackman CJ, et al. Evaluation of a SARS-CoV-2 surrogate virus neutralization test for detection of antibody in human, canine, cat and hamster sera. J Clin Microbiol. 2020;JCM.02504-20. https://doi.org/10.1128/JCM.02504-20
5. Gudbjartsson DF, Norddahl GL, Melsted P, Gunnarsdottir K, Holm H, Eythorsson E, et al. Humoral immune response to SARS-CoV-2 in Iceland. N Engl J Med. 2020;383:1724–34. https://doi.org/10.1056/NEJMoa2026116
6. Sun B, Feng Y, Mo X, Zheng P, Wang Q, Li P, et al. Kinetics of SARS-CoV-2 specific IgM and IgG responses in COVID-19 patients. Emerg Microbes Infect. 2020;9:940–8. https://doi.org/10.1080/22221751.2020.1762515
7. Folegatti PM, Ewer KJ, Aley PK, Angus B, Becker S, Belij-Rammerstorfer S, et al.; on behalf of the Oxford COVID Vaccine Trial Group. Safety and immunogenicity of the ChAdOx1 nCoV-19 vaccine against SARS-CoV-2: a preliminary report of a phase 1/2, single-blind, randomised controlled trial. Lancet. 2020;396:467–78. https://doi.org/10.1016/S0140-6736(20)31604-4
8. van Doremalen N, Lambe T, Spencer A, Belij-Rammerstorfer S, Purushotham JN, Port JR, et al. ChAdOx1 nCoV-19 vaccine prevents SARS-CoV-2 pneumonia in rhesus macaques. Nature. 2020;586:578–82. https://doi.org/10.1038/s41586-020-2608-y
9. Deng W, Bao L, Liu J, Xiao C, Liu J, Xue J, et al. Primary exposure to SARS-CoV-2 protects against reinfection in rhesus macaques. Science. 2020;369:818–23. https://doi.org/10.1126/science.abc5343

Address for correspondence: Huynh Kim Mai, 8-9-10 Tran Phu, Xuong Huan Ward, Nha Trang City, Khanh Hoa Province, Vietnam; email: mai064@yahoo.com and Le Van Tan, 764 Vo Van Kiet, District 5, Ho Chi Minh City, Vietnam; email: tanlv@oucru.org

Prevalence and Time Trend of SARS-CoV-2 Infection in Puducherry, India, August–October 2020

Sitanshu Sekhar Kar, Sonali Sarkar, Sharan Murali, Rahul Dhodapkar, Noyal Mariya Joseph, Rakesh Aggarwal

Author affiliation: Jawaharlal Institute of Postgraduate Medical Education and Research, Puducherry, India

DOI: https://doi.org/10.3201/eid2702.204480

We conducted 3 population-based cross-sectional surveys, at 1-month intervals, to estimate the prevalence and time-trend of severe acute respiratory syndrome coronavirus 2 infection in Puducherry, India. Seropositivity rate increased from 4.9% to 34.5% over 2 months and was 20-fold higher than the number of diagnosed cases of infection.

The magnitude of the ongoing pandemic of coronavirus disease (COVID-19), caused by infection with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has not been fully assessed because most those infected have no or mild symptoms, and thus do not undergo viral nucleic acid or antigen testing (*1*–*3*). Determining the proportion of a population that has had infection at various time points is essential for understanding the dynamics of an epidemic in a particular area.

Puducherry district, population ≈1.25 million, is located in southern India. Its earliest recorded case of COVID-19 was in March 2020; it had 7 total cases by the end of May, 67 by end of June, and 663 by end of July 2020 (*4*). The district followed national COVID-19 management guidelines, including testing all symptomatic persons and their high-risk contacts.

We conducted 3 community-based serologic surveys for SARS-CoV-2 antibodies in Puducherry at 1-month intervals, i.e., during August 11–16, September 10–16, and October 12–16, 2020 (Figure). Each survey included 900 adults selected using a multistage sampling procedure. In the initial stages, we chose 30 clusters, including 21 of 90 urban wards and 9 of 62 villages, using a probability proportional to size with replacement method; this method replicated the urban-to-rural ratio (70:30) of the district's population. Thereafter, in each cluster, we chose 30 households by systematic random sampling; we collected blood from 1 adult (≥18 years of age) in each household using a modified Kish method (*5*,*6*). The data from these surveys represent the cumulative proportion of

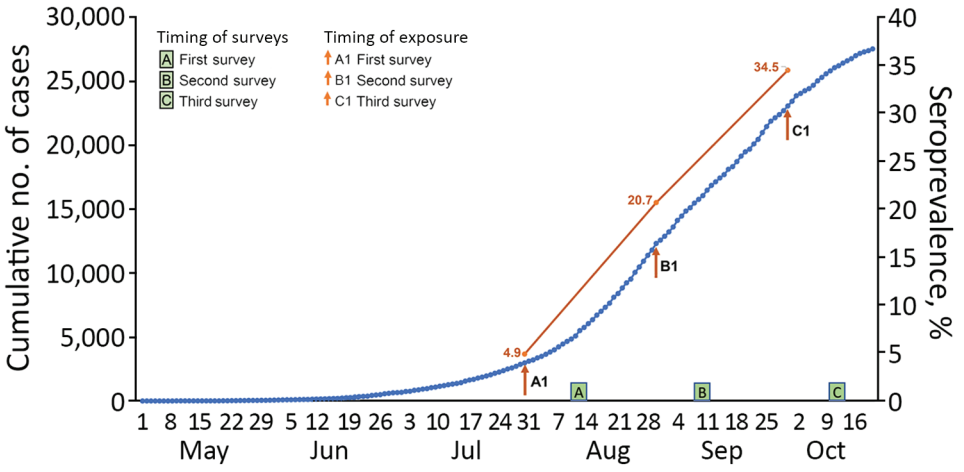

Figure. Prevalence of severe acute respiratory syndrome coronavirus 2 infection in 3 surveys in Puducherry district, India, 2020. Arrows indicate the timepoint 2 weeks before the midpoint of each of 3 surveillance periods.

population in Puducherry who had been infected with SARS-CoV-2 at ≈2 weeks before midpoint of each survey, i.e., at the end of July, August, and September 2020 (Figure). We obtained approval from Jawaharlal Institute's ethics committee and informed written consent from participants.

We tested all serum specimens using a commercial electrochemiluminescence-based microparticle immunoassay with 99.5% sensitivity and 99.8% specificity (Elecsys Anti-SARS-CoV-2; Roche, https://www.roche.com) (*7*) for qualitative detection of antibodies against recombinant nucleoprotein antigen of

Table. Seroprevalence of SARS-CoV-2 antibodies in 3 surveys in Puducherry, India, 2020*

	August 11–16, n = 869		September 10–16, n = 898		October 12–16, n = 900	
Variable	No. positive/ no. tested	% (95% CI)	No. positive/ no. tested	% (95% CI)	No. positive/ no. tested	% (95% CI)
Crude prevalence	43/869	4.9 (3.5–6.4)	186/898	20.7 (18.0–23.3)	311/900	34.5 (31.5–37.7)
Age category, y						
18–29	8/170	4.7 (1.5–7.8)	33/165	20.0 (13.9–26.1)	58/180	32.2 (25.8–39.3)
30–44	13/295	4.4 (2.1–6.7)	58/277	20.9 (16.2–25.7)	92/252	36.5 (30.8–42.6)
45–59	13/242	5.4 (2.5–8.2)	64/271	23.6 (18.5–28.7)	101/259	39.0 (33.2–45.0)
≥60	9/162	5.6 (2.0–9.1)	31/185	16.7 (11.4–22.1)	60/209	28.7 (23.0–35.1)
Sex						
M	16/439	3.6 (1.9–5.4)	95/443	21.4 (17.6–25.2)	126/406	31.0 (26.7–35.6)
F	27/428	6.3 (4.0–8.6)	91/455	20.0 (16.3–23.6)	183/491	37.2 (33.1–41.6)
Residence setting†						
Urban	35/609	5.7 (3.9–7.5)	130/629	20.7 (17.5–23.8)	225/628	35.8 (32.1–39.7)
Rural	8/260	3.1 (1.0–5.2)	56/269	20.8 (16.0–25.7)	86/272	31.6 (26.3–37.4)
Occupation‡						
Healthcare workers	2/29	6.9 (1.0–22.8)	4/32	12.5 (1.0–24.0)	18/66	27.2 (18.0–39.0)
Other frontline workers	0/22	0	8/23	34.8 (15.3–54.2)	6/15	40.0 (19.0–64.2)
Others	41/818	5.0 (3.5–6.5)	174/843	20.6 (17.9–23.4)	287/819	35.0 (31.8–38.3)
Other characteristics						
COVID-19	4/34	11.8 (9.3–22.6)	16/47	34.0 (20.5–47.6)	82/184	44.5 (37.5–51.7)
COVID-19 diagnosis	3/3	100	3/7	42.9 (6.1–79.5)	25/29	86.2 (69.4–94.5)
COVID-19 symptoms in last 6 mo	8/85	9.4 (3.2–15.6)	10/44	22.7 (10.3–35.1)	85/148	57.4 (49.3–65.1)
Cumulative case incidence (cumulative incidence ratio)§	2,987 (0.25%)		12,331 (1.03%)		23,080 (1.92%)	
Infection-to-case ratio¶	4.9%/0.25% = 19.6		20.9%/1.03% = 20.0		34.5%/1.92% = 18.0	
Cumulative deaths	43		187		441	
Infection fatality ratio (cumulative deaths per 100,000 infected persons)#	73.4		75.8		106.1	

*COVID-19, coronavirus disease; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.
†Definitions used by the Office of the Registrar General & Census Commissioner, Government of India.
‡Other frontline workers included police officers, teachers, revenue officers, persons involved in COVID-19 response.
§Calculated for data gathered until 2 weeks before the midpoint of the survey.
¶Infection-to-case ratio was calculated as crude seroprevalence / cumulative incidence ratio.
#Infection-fatality ratio was calculated as cumulative deaths/crude prevalence × estimated population of the district.

SARS-CoV-2, following manufacturer's instructions. Specimens with cutoff index ≥1.0 were considered seroreactive; cutoff index was the ratio of chemiluminescence signal of sample with that of the reference sample. For each timepoint, we calculated crude prevalence rate with 95% CI using a binomial model. In addition, we used the data on cumulative cases and deaths recorded until each timepoint (*4*) to calculate infection-to-case and infection-to-death ratios.

We visited 890 households and recruited 869 participants (response rate 97.8%) in August, 902 households from which we recruited 898 (99.8%) participants in September, and 900 households from which we recruited 900 (100%) participants in October. We tracked cumulative number of reported cases (cumulative incidence rates) of COVID-19 and deaths due to the disease in the district at each timepoint (Table) (*4*). In each survey, the median age was in the mid-40s with nearly equal numbers of men and women. Crude seroprevalence of SARS-CoV-2 antibodies increased from 4.9% (95% CI, 3.5%–6.4%) in August, to 20.7% (18.0%–23.3%) in September, to 34.5% (31.5%–37.7%) in October. These rates indicate that ≈16% of the district's population acquired SARS-CoV-2 infection during August and ≈14% during September 2020. These rates are much higher than those reported from other parts of the world (*8*), but are similar to a high seropositivity rate of 57% reported in slum areas of Mumbai (*9*).

The infection-to-case ratios were similar across the 3 surveys: 19.6 in August, 20.0 in September, and 18.0 in October. These results indicated that, despite implementing the strategies of testing all symptomatic persons and of aggressive contact tracing in the district, only a small proportion of SARS-CoV-2 infections had been diagnosed at each timepoint. This contrasts with the data from high-income countries (*10*) and could be related to the younger age distribution in the population of India, partial immunity due to other prior coronavirus or other infections, or both.

Strengths of our study include representativeness of the population by its random selection procedure and high participation rate; repeat testing in the same primary sampling units to reduce variability over time; and the use of an assay with high sensitivity and specificity. Limitations included the possibility that some persons did not show development of antibodies following infection, leading to a falsely low seroprevalence; possible loss of antibodies over time, leading to a falsely low rise of seroprevalence with time; and dependence of seroprevalence on the assay used.

Our data indicate a high rate of transmission of SARS-CoV-2 in Puducherry during August and September 2020, with some evidence of slowing over time. By the end of September, nearly one third of the population were infected with SARS-CoV-2, a much larger proportion than those diagnosed with COVID-19. These findings should help guide the response to COVID-19 in our district.

Acknowledgments

We thank the members of our survey and laboratory teams, and the study participants for their help.

This project was funded by an intramural grant from the Jawaharlal Institute of Postgraduate Medical Education and Research, Puducherry, India.

About the Author

Dr. Kar is an additional professor of preventive and social medicine at the Jawaharlal Institute of Postgraduate Medical Education and Research, Puducherry, India. His research interests include disease epidemiology.

References

1. World Health Organization. Population-based age-stratified seroepidemiological investigation protocol for coronavirus 2019 (COVID-19) infection, 26 May 2020. 2020 [cited 2020 Aug 24]. https://apps.who.int/iris/handle/10665/332188
2. World Health Organization. Report of the WHO-China joint mission on coronavirus disease 2018 (COVID-19). 2020 [cited 2020 Aug 24]. https://www.who.int/docs/default-source/coronaviruse/who-china-joint-mission-on-covid-19-final-report.pdf
3. Varghese GM, John R, Manesh A, Karthik R, Abraham OC. Clinical management of COVID-19. Indian J Med Res. 2020;151:401–10. https://doi.org/10.4103/ijmr.IJMR_957_20
4. Health Department, Puducherry. COVID-19 Puducherry. 2020 [cited 2020 Oct 10]. https://covid19dashboard.py.gov.in
5. Lavrakas P. Kish selection method. In: Encyclopedia of survey research methods. 2020 Oct 30 [cited 2020 Nov 30]. https://methods.sagepub.com/reference/encyclopedia-of-survey-research-methods/n262.xml
6. Kumar MS, Bhatnagar T, Manickam P, Kumar VS, Rade K, Shah N, et al. National sero-surveillance to monitor the trend of SARS-CoV-2 infection transmission in India: protocol for community-based surveillance. Indian J Med Res. 2020;151:419–23. https://doi.org/10.4103/ijmr.IJMR_1818_20
7. Roche Diagnostics. Elecsys Anti-SARS-CoV-2. 2020 [cited 2020 Oct 10]. https://diagnostics.roche.com/global/en/products/params/elecsys-anti-sars-cov-2.html
8. Lai C–C, Wang J-H, Hsueh P-R. Population-based seroprevalence surveys of anti-SARS-CoV-2 antibody: an up-to-date review. Int J Infect Dis. 2020;101:314–322. https://doi.org/10.1016/j.ijid.2020.10.011
9. Tata Institute of Fundamental Research. Technical details: SARS-CoV2 serological survey in Mumbai by NITI-BMC-TIFR. 2020 [cited 2020 Nov 4]. https://www.tifr.res.in/TSN/article/Mumbai-Serosurvey%20Technical%20report-NITI.pdf

10. Stringhini S, Wisniak A, Piumatti G, Azman AS, Lauer SA, Baysson H, et al. Seroprevalence of anti-SARS-CoV-2 IgG antibodies in Geneva, Switzerland (SEROCoV-POP): a population-based study. Lancet. 2020;396:313–9. https://doi.org/10.1016/S0140-6736(20)31304-0

Address for correspondence: Sitanshu Sekhar Kar, Jawaharlal Institute of Postgraduate Medical Education—Preventive and Social Medicine, JIPMER Campus, Puducherry, Puducherry 605006 India; email: drsitanshukar@gmail.com

SARS-CoV-2 Infection and Mitigation Efforts among Office Workers, Washington, DC, USA

Samira Sami, Nga Vuong, Halie Miller, Rachael Priestley, Matthew Payne, Garrett Licata-Portentoso, Jan Drobeniuc, Lyle R. Petersen

Author affiliations: Centers for Disease Control and Prevention, Atlanta, Georgia, USA (S. Sami, H. Miller, R. Priestley, J. Drobeniuc); Centers for Disease Control and Prevention, Fort Collins, Colorado, USA (N. Vuong, L.R. Petersen); Federal Emergency Management Agency, Washington, DC, USA (M. Payne, G. Licata-Portentoso)

DOI: https://doi.org/10.3201/eid2702.204529

Despite mitigation efforts, 2 coronavirus disease outbreaks were identified among office workers in Washington, DC. Moderate adherence to workplace mitigation efforts was reported in a serologic survey; activities outside of the workplace were associated with infection. Adherence to safety measures are critical for returning to work during the pandemic.

On March 19, 2020, the Federal Emergency Management Agency (FEMA) activated the National Response Coordination Center in Washington, DC, USA, in response to the coronavirus disease (COVID-19) pandemic. At that time, cases were rapidly increasing in Washington, DC; ≈200 cases had been reported since March 7. Although city officials ordered closure of nonessential businesses on March 24, FEMA remained open. To protect staff from severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection, all persons entering FEMA headquarters underwent symptom and temperature screening. On April 5, after a cluster of 6 epidemiologically linked cases was identified, additional mitigation efforts were implemented, including requiring face masks at all times, requiring that a distance of 6 feet be maintained between employees, and reducing occupancy in the open office space building from a daily average of 1,300 to 400 persons.

To examine workplace and community factors associated with infection, we conducted a serologic survey of SARS-CoV-2 antibodies among staff who worked on site after the mitigation efforts had been implemented. To assess the effect of mitigation efforts in the workplace, we examined occupational case surveillance data.

Staff who worked in the FEMA building during April 1–22 were identified by using turnstile records and were invited by email to participate in a survey. Persons who had had symptoms of COVID-19 within 2 weeks of the survey were ineligible to participate. During April 23–29, consenting participants completed a self-administered, online questionnaire assessing demographics and potential community and workplace exposure to SARS-CoV-2, and blood samples were collected.

Blood samples were tested for SARS-CoV-2 IgG by using ELISA targeting the SARS-CoV-2 receptor-binding domain protein (*1*). Indeterminate test results or incomplete questionnaires resulted in the exclusion of 10 participants. Characteristics of seropositive and seronegative groups were compared by using the Fisher exact test, and 2-sided p values <0.05 were considered statistically significant. Reports of confirmed COVID-19 cases among staff who worked at FEMA headquarters during March–October 2020 were obtained from occupational health records. This activity was reviewed by the Centers for Disease Control and Prevention and deemed public health surveillance.

Of the 466 survey participants, 15 (3.2%) tested positive for SARS-CoV-2 antibodies. Seroprevalence did not vary by sex or age (Table). Of those who tested positive, 11 (73%) reported never having been tested for SARS-CoV-2 by nasal or throat swab, and 8 (53%) reported no symptoms suggestive of SARS-CoV-2 infection since January 15, 2020 (*2*). On average, participants had spent 20.5 (± 12.0 SD) days in the FEMA building since March 2020. We found no significant difference in workplace