Characteristics of SARS-CoV-2 positive individuals in California from two periods during notable decline in incident infection

Lao-Tzu Allan-Blitz1 | Isaac Turner2 | Fred Hertlein2 | Jeffrey D. Klausner3

1Division of Global Health Equity, Department of Medicine, Brigham and Women’s Hospital, Boston, Massachusetts, USA
2Curative Inc., San Dimas, California, USA
3Department of Population and Public Health Sciences, Keck School of Medicine, University of Southern California, Los Angeles, California, USA

Correspondence
Lao-Tzu Allan-Blitz, Department of Medicine, Brigham and Women’s Hospital, 75 Francis Street, Boston, MA 02115, USA.
Email: lallan-blitz@partners.org
Jeffrey D. Klausner, Department of Preventive Medicine, Keck School of Medicine, University of Southern California, Los Angeles, CA 90033, USA.
Email: jdklausner@med.usc.edu

1| INTRODUCTION

Between February and May 2021, the weekly case rate of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) declined in California from 270 to 32.9 cases per 100 000 individuals.1 The cause of the dramatic decline is likely multifactorial but greatly influenced by population-level immunity due to prior infection and increasing vaccination coverage (see Figure 1).2

SARS-CoV-2, however, continues to be transmitted heterogeneously among different subsets of the population.3 The recent resurgence (from 17 to 173 cases per 100 000 individuals between June and August in California)1 and fears that SARS-CoV-2 variants4 may escape immunity warrant continued epidemic monitoring. We aimed to characterize individuals testing positive for SARS-CoV-2 during the period of notable decline in case rate in California to generate hypotheses for understanding shifting risk dynamics that may contribute to the current trend in viral transmission.

2| METHODS

We conducted a retrospective cohort study among individuals presenting for SARS-CoV-2 polymerase chain reaction (PCR) testing to one of 150 drive-through publicly accessible commercial sites in California at two periods: (a) February 23-March 3, 2021, and (b) between April 15 and 30 2021. Testing sites were located in Los Angeles, Riverside, San Mateo, Berkeley, Menlo Park, Maywood, and Rancho Mirage. As a part of the testing program, all individuals completed a confidential online survey reporting demographic and employment information, if in the last 14 days, they had been contacted by local public health authorities about a known SARS-CoV-2 exposure or visited any of a list of public places, as well as report of symptoms at the time of testing. The survey was completed via personal or provided smart device. All individuals were included in the analysis who had testing data available, regardless of survey completion.

We collected data on PCR results from healthcare worker-observed self-collected oral swab specimens, which have been shown to have a near 100% positive and negative percent agreement with clinician-collected nasopharyngeal swabs5 and were processed with standard PCR methods using a modified Food and Drug Administration (FDA)-authorized Center for Disease Control and Prevention testing protocol as has been previously reported.6 For that PCR assay, a cycle threshold value of 30 corresponded to approximately 3000 viral copies per mL (range 1500-6000 copies per mL) of solution.

We then conducted a cross-sectional descriptive analysis to determine the frequency of infection among testers and positivity ratios for the two periods based on each of the above characteristics. We stratified our analysis by Hispanic heritage to account for confounding.7 The Mass General Brigham institutional review board deemed the analysis of de-identified data did not constitute human subjects’ research (2020P003530). All analyses were conducted using STATA 15.1 (StataCorp, College Station, TX).
3 | RESULTS

We analyzed 114,789 test results (see Table 1). Of 529,07 results between February 23–March 3, 2021, 2,679 (5.1%) were positive. Of 61,882 test results from April 15–30, 1,579 (2.6%) were positive. Testers included 48.0% who identified with Hispanic heritage, and 54.6% reported female sex.

In the first period, the positivity of SARS-CoV-2 infection among Hispanic and non-Hispanic testers was 7.6% and 2.8%, respectively (P-value<.001). In the second period, the positivity among Hispanic and non-Hispanic testers was 3.0% and 2.0%, respectively (P-value = .09). Of individuals testing positive, 1,309 (48.8%) and 715 (45.3%) reported contact with a known case in the last 14 days in the first and second period, respectively.

Among Hispanic testers during the first period, we found a high positivity of infection among children (11.8%) and those who reported mixed heritage (6.5%). We found consistently elevated positivity through both periods among individuals reporting any known exposure in the past 14 days (16.1% and 10.2%, respectively), individuals reporting employment as disability care providers (5.5% and 5.5%, respectively), food service providers (8.6% and 3.7%, respectively), and employment in retail or manufacturing (8.3% and 3.9%, respectively).

Among non-Hispanic testers, we found consistently elevated SARS-CoV-2 positivity among individuals reporting employment in retail or manufacturing in both periods (3.9% and 2.6%, respectively), as well as among testers reporting any known exposure in the past 14 days (10.2% and 10.6%, respectively).

4 | DISCUSSION

We evaluated SARS-CoV-2 positivity and potential exposures among those presenting for testing during two periods in California, identifying notable positivity among testers of Hispanic heritage and those reporting a recent known exposure. The current trends in SARS-CoV-2 case rates across the United States are again increasing. An epidemiologic understanding of those most at risk for infection is essential as the transmission dynamics shift, in order to guide future prevention efforts.

We found high test positivity among Hispanic testers and among children specifically during the first period, supporting the key role of within household transmission. Because schools were mostly closed during the initial period in California, and the reopening of schools predominantly overlapped with the second observation period, it is unlikely that school attendance is contributing to the continued spread of infection. Household crowding is more common among

---

**FIGURE 1** New severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infections against percent vaccinated in California, January–March 2021. This figure shows percent vaccinated (by first and second dose) and new SARS-CoV-2 cases per 100,000 individuals in California between January and March 2021. Data extrapolated from U.S. COVID Risk & Vaccine Tracker.
# Table 1
Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) positivity among Hispanics and non-Hispanic individuals from California comparing February 23 to March third and April 15 to April 30, 2021

| Age                  | Hispanic ethnicity | Non-hispanic ethnicity |
|----------------------|--------------------|-------------------------|
|                      | Total              | Feb 24 | 929 | 30 | 119 | Apr 1907 | 442 | 222 | 2.5 | Feb 7.6 | Apr 3.0 | Feb vs Apr 2.5 | Total | Feb 27 | 978 | 31 | 763 | Apr 772 | 672 | 2 | 21 | Feb vs Apr 1.3 |
| <18 years            | 2889               | 8264 | 826 | 341 | 200 | 11.8% | 6.4% | 7.6% | 2 | 2.4% | 3 | 2.0% | 4.9 | 3.0% | 2.5 | 3.1% | 4.2% | 1.2 |
| 18 to 24 years       | 4424               | 5713 | 6865 | 6770 | 442 | 222 | 13.7% | 6.4% | 6.7% | 3 | 3.3% | 2.1 | 3.0% | 2.6 | 3.2% | 1.7 |
| 25 to 34 years       | 6865               | 6770 | 442 | 222 | 13.7% | 6.4% | 6.7% | 3 | 3.3% | 2.1 | 3.0% | 2.6 | 3.2% | 1.7 |
| 35 to 49 years       | 5914               | 5530 | 419 | 186 | 7.1% | 6.4% | 13.7% | 3.0% | 6.7% | 3 | 3.3% | 2.1 | 3.0% | 2.6 | 3.2% | 1.7 |
| 50 to 64 years       | 3865               | 3002 | 345 | 97 | 8.9% | 6.4% | 13.7% | 3.0% | 6.7% | 3 | 3.3% | 2.1 | 3.0% | 2.6 | 3.2% | 1.7 |
| ≥65 years            | 970                | 840 | 79 | 28 | 8.1% | 6.4% | 13.7% | 3.0% | 6.7% | 3 | 3.3% | 2.1 | 3.0% | 2.6 | 3.2% | 1.7 |

| Gender               | Hispanic ethnicity | Non-hispanic ethnicity |
|----------------------|--------------------|-------------------------|
| Female               | 13 764             | 17 110 | 951 | 462 | 6.9% | 2.7% | 2.6 | Feb 13.7% | 23 | 110 | 462 | 2.7% | 2.6 |
| Male                 | 11 111             | 12 947 | 954 | 444 | 8.6% | 3.4% | 2.5 |

| Heritage             | Hispanic ethnicity | Non-hispanic ethnicity |
|----------------------|--------------------|-------------------------|
| American Indian or Alaska Native | 245 | 338 | 16 | 4 | 6.5% | 1.2% | 5.5 | Feb 6.5% | 16 | 4 | 6.5% | 1.2% | 5.5 |
| Black or African American | 203 | 251 | 11 | 10 | 5.4% | 4.0% | 1.4 | Feb 5.4% | 11 | 10 | 5.4% | 4.0% | 1.4 |
| Native Hawaiian or Another Pacific Island | 73 | 70 | 10 | 4 | 13.7% | 5.7% | 2.4 | Feb 13.7% | 10 | 4 | 13.7% | 5.7% | 2.4 |
| Asian                | 95 | 134 | 3 | 0 | 3.2% | 0.0% | * |
| Multiracial          | 401 | 514 | 18 | 15 | 4.5% | 2.9% | 1.5 | Feb 4.5% | 18 | 15 | 4.5% | 2.9% | 1.5 |
| White                | 5365 | 6756 | 330 | 195 | 6.2% | 2.9% | 2.1 | Feb 6.2% | 330 | 195 | 6.2% | 2.9% | 2.1 |
| Other/prefer not to share | 16 820 | 20 072 | 1450 | 629 | 8.6% | 3.1% | 2.8 | Feb 8.6% | 1450 | 629 | 8.6% | 3.1% | 2.8 |

| Employment           | Hispanic ethnicity | Non-hispanic ethnicity |
|----------------------|--------------------|-------------------------|
| Agricultural or food manufacturing worker | 183 | 232 | 12 | 10 | 6.6% | 3.1% | 2.1 | Feb 6.6% | 12 | 10 | 6.6% | 3.1% | 2.1 |
| Construction worker  | 4 | 9 | 0 | 3 | 0.0% | 33.3% | 0.0 | Feb 0.0% | 0 | 3 | 0.0% | 33.3% | 0.0 |
| Correctional facility | 41 | 34 | 5 | 3 | 12.2% | 8.8% | 1.4 | Feb 12.2% | 5 | 3 | 12.2% | 8.8% | 1.4 |
| Delivery or ride share | 2 | 6 | 0 | 1 | 0.0% | 16.7% | 0.0 | Feb 0.0% | 0 | 1 | 0.0% | 16.7% | 0.0 |
| Disability care provider | 440 | 451 | 24 | 25 | 5.5% | 5.5% | 1.0 | Feb 5.5% | 24 | 25 | 5.5% | 5.5% | 1.0 |
| Education            | 1160 | 3812 | 44 | 23 | 3.8% | 0.6% | 6.3 | Feb 3.8% | 44 | 23 | 3.8% | 0.6% | 6.3 |
| Emergency services   | 213 | 253 | 10 | 4 | 4.7% | 1.6% | 3.0 | Feb 4.7% | 10 | 4 | 4.7% | 1.6% | 3.0 |
| First responder      | 5 | 4 | 0 | 0 | 0.0% | 0.0% | * |
| Food services        | 1847 | 1859 | 159 | 68 | 8.6% | 3.7% | 2.4 | Feb 8.6% | 159 | 68 | 8.6% | 3.7% | 2.4 |
| TABLE 1  | Hispanic ethnicity | Non-hispanic ethnicity |
|-----------|------------------|-----------------------|
|           | Total            | No. SARS-CoV-2 positive | SARS-CoV-2 positivity | Positivity ratio | Total            | No. SARS-CoV-2 positive | SARS-CoV-2 positivity | Positivity ratio |
|           | Feb              | Apr                   | Feb                  | Apr             | Feb vs Apr       | Feb              | Apr                   | Feb vs Apr       |
| Feb       | April            | February              | April                | February        | April            | February         | April                | April           |
| Feb 24929| Apr 30119        | Feb 1907              | Apr 907              | Feb 7.6%        | Apr 3.0%         | Feb vs Apr 2.5   | Feb 27978            | Apr 31763        |
| Feb 1797 | Apr 907          | Feb 62                | Apr 34               | Feb 4.6%        | Apr 1.9%         | Feb vs Apr 2.4   | Feb 1812             | Apr 2182         |
| Feb 1338 | Apr 1779         | Feb 62                | Apr 34               | Feb 4.6%        | Apr 1.9%         | Feb vs Apr 2.4   | Feb 1812             | Apr 2182         |
| Feb 198  | Apr 248          | Feb 10                | Apr 3               | Feb 5.1%        | Apr 3.2%         | Feb vs Apr 1.6   | Feb 178              | Apr 255           |
| Feb 1698 | Apr 1480         | Feb 141               | Apr 58              | Feb 8.3%        | Apr 3.9%         | Feb vs Apr 2.1   | Feb 1116             | Apr 890           |
| Public exposures | | | | | | | | |
| Bars      | 136              | 338                   | 0                    | 2               | 0.0%             | 0.6%             | 0                   | 311              | 625               |
| Restaurants | 1269             | 3232                  | 13                   | 32              | 1.0%             | 1.0%             | 1.0                 | 3168             | 5446              |
| Gas stations | 2076             | 2908                  | 46                   | 21              | 2.2%             | 0.7%             | 3.1                 | 3990             | 4750              |
| Public park | 1006             | 2704                  | 13                   | 24              | 1.3%             | 0.9%             | 1.5                 | 3337             | 4877              |
| Retail store | 1785             | 3862                  | 34                   | 36              | 1.9%             | 0.9%             | 2.0                 | 3739             | 5744              |
| Grocery store | 3603             | 6457                  | 78                   | 65              | 2.2%             | 1.0%             | 2.2                 | 6864             | 9132              |
| Place of work | 869              | 1204                  | 23                   | 7               | 2.6%             | 0.6%             | 4.6                 | 1346             | 1705              |
| Public transit | 413              | 954                   | 4                    | 9               | 1.0%             | 0.9%             | 1.0                 | 863              | 1237              |
| Place of worship | 243              | 549                   | 4                    | 3               | 1.6%             | 0.5%             | 2.5                 | 236              | 512               |
| Known COVID contact in last 14 days | | | | | | | | |
| No        | 17039            | 24551                 | 952                  | 503             | 5.6%             | 2.0%             | 2.7                 | 22315            | 27490             |
| Yes       | 5812             | 3917                  | 934                  | 400             | 16.1%            | 10.2%            | 1.6                 | 3662             | 2980              |

Abbreviation: COVID, coronavirus disease.
Hispanic communities,\(^9\) likely contributing to substantial intrafamilial transmission.

The disparities among testers identifying as individuals of minority heritage are consistent with prior studies,\(^7,10,11\) likely reflecting structural inequities continuing to put certain populations at increased risk of exposure due to inadequate protections. Differences in types of employment may play a key role such disparities.\(^12\) Our findings suggest that prevention strategies may benefit from focusing on businesses employing food service workers and disability care providers. Disability care providers are a particularly important population as the morbidity and mortality of SARS-CoV-2 infection are substantial among individuals of long-term care facilities.\(^13\) Thus, we encourage requiring vaccination among such employment categories. Further research is still needed to both address the underlying structural inequities and clarify the specific exposures within different subpopulations that contribute to sustained transmission.

Nearly half of infections in our testing population in both periods were among individuals who reported recent contact with someone known to be infected with SARS-CoV-2. Thus, contact tracing efforts, perhaps now more than ever, are essential for identifying and isolating remaining cases and testing and quarantine of those exposed.\(^14\) Incorporation of detailed exposure reporting at testing centers may complement contact tracing efforts and facilitate real-time monitoring of the variations in risk exposures; however, such data must be collected from both infected and uninfected persons.\(^15\) Additionally, continuing to encourage testing and vaccination among individuals with a known exposure will be essential.

Our study had several limitations. First, we analyzed laboratory-based data and could not account for individuals with repeat testing. Second, we were unable to collect detailed socioeconomic data in order to control for confounding factors. Data collection was also incomplete for several fields making further statistical analyses and modeling not possible. Thus, this study is hypothesis generating. The strengths of our study were the very large sample size, thus improving precision of our results, the unbiased collection of exposure data—when reported—prior to receiving testing results, and the inclusion of numerous testing sites across California, improving the generalizability of our results.

5 | CONCLUSIONS

We report SARS-CoV-2 positivity by ethnic heritage in California from two observation periods. We found notable SARS-CoV-2 positivity among Hispanic testers, testers with a known recent exposure, and variations in positivity by type of employment. Those findings are important because of the evolving epidemiology of those at risk, thus providing groundwork for future research and potentially informing public health strategies.

ACKNOWLEDGMENTS

The authors would like to acknowledge the cities of Los Angeles, Riverside, San Mateo, Berkeley, Menlo Park, Maywood, and Rancho Mirage.

FUNDING

Supported in part by a gift to the Keck School of Medicine of the University of Southern California by the W.M. Keck Foundation.

CONFLICT OF INTEREST

Dr. Allan-Blitz served as a consultant for Curative Inc., Fred Hertlein is an employee of Curative Inc., Isaac Turner is a Co-Founder and Chief Information Officer of Curative Inc., and Dr. Klausner is the independent medical director of Curative Inc. The above financial relationships had no involvement on study design, data collection, data analysis, interpretation of the data, writing of the report, or decision to submit for publication.

AUTHOR CONTRIBUTIONS

Conceptualization: Lao-Tzu Allan-Blitz, Isaac Turner, and Jeffrey D. Klausner.

Formal Analysis: Lao-Tzu Allan-Blitz and Fred Hertlein.

Writing (Original Draft): Lao-Tzu Allan-Blitz.

Writing (Review and Editing): Lao-Tzu Allan-Blitz, Isaac Turner, Fred Hertlein, and Jeffrey D. Klausner.

All authors have read and approved the final version of the manuscript.

Lao-Tzu Allan-Blitz had full access to all of the data in this study and takes complete responsibility for the integrity of the data and the accuracy of the data analysis.

TRANSPARENT STATEMENT

Lao-Tzu Allan-Blitz affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

DATA AVAILABILITY STATEMENT

The data are available upon request.

ORCID

Lao-Tzu Allan-Blitz https://orcid.org/0000-0002-4077-3476

REFERENCES

1. Centers for Disease Control and Prevention. COVID Data Tracker: United States COVID-19 Cases and Deaths by State. Last updated April 2nd 2021. Available at: https://covid.cdc.gov/covid-data-tracker/#cases_casesper100klast7days Accessed April 4th, 2021.
2. U.S. COVID Risk & Vaccine Tracker. Available at: https://covidactnow.org/?s=1793712 Last Accessed April 29th, 2021.
3. Centers for Disease Control and Prevention. COVID data tracker: Integrated county view. Available at: https://covid.cdc.gov/covid-data-tracker?CDS_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fcoronavirus%2F2019-ncov%2Fcases-updates%2Fcases-in-us.html#county-view Accessed 11/30/2020.
4. Galloway SE, Paul P, MacCannell DR, et al. Emergence of SARS-CoV-2 B.1.1.7 lineage - United States, December 29, 2020-January 12, 2021. MMWR Morb Mortal Wkly Rep. 2021;70(3):95-99.
5. Food and Drug Administration. Accelerated Emergency Use Authorization Summary: Curative SARS-CoV-2 Assay. Table 11. Available at: https://www.fda.gov/media/137089/download. Accessed March 24, 2021.

6. Kojima N, Turner F, Slepnev V, et al. Self-collected Oral fluid and nasal swab specimens demonstrate comparable sensitivity to clinician-collected nasopharyngeal swab specimens for the detection of SARS-CoV-2. *Clin Infect Dis*. 2020.

7. Macias Gil R, Marcelin JR, Zuniga-Blanco B, Marquez C, Mathew T, Piggott DA. COVID-19 pandemic: disparate health impact on the Hispanic/Latinx population in the United States. *J Infect Dis*. 2020; 222(10):1592–1595.

8. Cerami C, Rapp T, Lin FC, Tompkins K, Basham C, Muller MS, et al. High household transmission of SARS-CoV-2 in the United States: living density, viral load, and disproportionate impact on communities of color. *medRxiv*. 2021.

9. Burr JA, Mutchler JE, Gerst K. Patterns of residential crowding among Hispanics in later life: immigration, assimilation, and housing market factors. *J Gerontol B Psychol Sci Soc Sci*. 2010;65(6):772-782.

10. Ogedegbe G, Ravenell J, Adhikari S, et al. Assessment of racial/ethnic disparities in hospitalization and mortality in patients with COVID-19 in new York City. *JAMA Netw Open*. 2020;3(12):e2026881.

11. Anand S, Montez-Rath M, Han J, et al. Prevalence of SARS-CoV-2 antibodies in a large nationwide sample of patients on dialysis in the USA: a cross-sectional study. *Lancet*. 2020;396(10259):1335–1344.

12. Chen Y-H, Glymour M, Riley A, Balmes J, Duchowny K, Harrison R, Matthay E, Bibbins-Domingo K. Excess mortality associated with the COVID-19 pandemic among Californians 18–65 years of age, by occupational sector and occupation: March through November 2020. *PLOS ONE*. 2021;16(6):e0252454. https://doi.org/10.1371/journal.pone.0252454

13. Kaiser Family Foundation. State reports of long-term care facility cases and deaths related to COVID-19 (as of October 16, 2020). Accessed October 17, 2020. Available at: https://www.kff.org/health-costs/issue-brief/state-data-and-policy-actions-to-address-coronavirus/#top.

14. Hellewell J, Abbott S, Gimma A, et al. Feasibility of controlling COVID-19 outbreaks by isolation of cases and contacts. *Lancet Glob Health*. 2020;8(4):e488–e96.

15. Allan-Blitz L-T, Klausner JD. Response to: Seroprevalence of SARS-CoV-2 following the largest initial epidemic wave in the United States: Findings from New York City, May 13-July 21, 2020. *J Infect Dis*. 2021;224(3):556–557.

How to cite this article: Allan-Blitz L-T, Turner I, Hertlein F, Klausner JD. Characteristics of SARS-CoV-2 positive individuals in California from two periods during notable decline in incident infection. *Health Sci Rep*. 2021;4:e384. doi: 10.1002/hsr2.384