Seroprevalence of SARS-CoV-2 Specific Antibodies Among Adults in Los Angeles County

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Introduction

A lack of knowledge about the extent of the COVID-19 epidemic challenges public health response and planning. Most reports of confirmed cases rely on PCR-based testing of symptomatic patients.[1] These estimates of confirmed COVID-19 cases miss those who have recovered from infection, those with mild or no symptoms, and those with symptoms who have not been tested due to limited availability of PCR-based tests. Quantifying the extent of infection is crucial for estimating the infected fatality rate of COVID-19.[2-4] Conducting serologic tests in representative samples is the best available approach for estimating cumulative incidence of SARS-CoV-2 infection, as serologic tests identify both active and past infections.

Methods

We conducted serologic testing for SARS-CoV-2 specific antibodies in a representative sample of 865 adults in Los Angeles County using a rapid lateral flow immunoassay test (Premier Biotech, Minneapolis MN). Residents within a 15-mile radius of the testing site were eligible for participation in the study. Participants were offered testing at 6 study sites on April 10 and April 11, 2020; those unable to come to the testing sites were offered in-home testing. We used a proprietary database representative of the county maintained by LRW Group, a market research firm, to select participants. A random sample of these residents were invited to participate in the study on April 4 with the goal of recruiting 1,000 participants for testing. Quotas for enrollment in the study for population sub groups were set based on age, gender, race, and ethnicity distribution of Los Angeles County residents. Participation in the study was restricted to one adult per household. Each test was read by at least two study staff members; 2 test results were inconclusive due to faulty test kits and were removed from the analysis sample.

We used these data to estimate the population prevalence of COVID-19. First, we report the unweighted proportion of positive tests (either IgM or IgG) in the analysis sample (N=863). Second, we report the weighted proportion of positive tests in the analysis sample. Weights were calculated to match the gender-age (18-34, 35-54, 55+), ethnicity, and income (<$50K, $50k - $100k, $100k+) distribution of our sample to the Los Angeles county 2018 census estimates. Table 1 shows the unweighted and weighted distribution of our sample based on these population characteristics. Third, we adjust the weighted and unweighted proportion of positive tests for the sensitivity and specificity of the test to estimate the true population prevalence of COVID-19. Estimates of the sensitivity (79.1%) and specificity (100%) of the test kits were obtained from an independent assessment of the test kits performed at a laboratory at Stanford University. The study was approved by the Los Angeles County Department of Public Health Institutional Review Board.

Results

Out of 863 adults tested in LA County, 35 or 4.06% (CI: 2.74% to 5.37%) tested positive. The weighted proportion of participants who tested positive was 4.14% (CI: 2.81% to 5.47%). After adjusting for test sensitivity and specificity, the unweighted and weighted prevalence of SARS-CoV-2 antibodies in our sample was 5.13% (CI: 3.46% to 6.79%) and 5.23% (CI: 3.55% to 6.92%), respectively. Our estimates represent the cumulative incidence of COVID-19 in Los Angeles County on April 9. Given that Los Angeles County's adult population is about 7.9 million, our weighted adjusted estimate implies that between 280,000 to 547,000 adults had been infected with SARS-CoV-2 by April 9, which is 35 to 68 times higher than the 7,995 cumulative number of confirmed infections in the County on that date.

Discussion

Our results imply that the number of SARS-CoV-2 infections in the community far exceed the number of confirmed cases. This implies that fatality rates based on confirmed cases may be orders of magnitude higher than fatality rates based on number of infections. It also implies that contact tracing methods to limit the spread of infection will face considerable challenges.

The study has limitations. On the one hand, our estimated prevalence could be biased upwards if those who had a higher risk of SARS-CoV-2 infection were more likely to participate. On the other hand, our results would be biased downward if those who had symptoms consistent with COVID-19 islolated themselves and did not participate. New data on specificity and sensitivity of the test kits would also influence results; a lower sensitivity would imply higher prevalence, and lower specificity would imply lower prevalence.

Further population representative serological testing is warranted to track the progress of the epidemic throughout the country and the world.

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Table 1: Unweighted and weighted characteristics of study participants and Los Angeles county residents

Characteristics	Sample frequency (N=863)	Sample Proportion (%)		Los Angeles County Population Proportion (%)
		Unweighted	Weighted	
Gender				
Male	347	40.2%	48.3%	48.8%
Female	514	59.6%	51.4%	51.2%
Non-binary	2	0.2%	0.2%	NA
Age				
18-34 years	191	22.1%	32.9%	32.8%
35-54 years	475	55.0%	35.0%	34.5%
55+ years	197	22.8%	32.1%	32.7%
Ethnicity				
Hispanic (including multi-race)	190	22.0%	48.4%	48.6%
African American (Non-Hispanic)	72	8.3%	7.8%	7.8%
Asian	98	11.4%	14.5%	14.6%
Caucasian/Other	503	58.3%	29.3%	29.0%
Income				
Under $50,000	175	20.3%	32.1%	35.2%
$50,000-$99,999	253	29.3%	26.4%	28.2%
$100,000 or more	367	42.5%	33.6%	36.5%
Missing	68	7.9%	7.8%	NA