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Seroprevalence of SARS-CoV-2 Antibodies in the US Adult Asymptomatic Population as of September 30, 2020

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Introduction

Because severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection may be asymptomatic or minimally symptomatic, counts of officially reported cases may substantially underestimate the overall burden of infection in the United States.[1] Viral serologic testing may provide a more accurate estimate of cumulative disease prevalence. This cross-sectional study assesses the seroprevalence of SARS-CoV-2 in a nationwide, self-reported well population.

Methods

In September 2020, a national adult convenience sample of 61 910 self-reported well life insurance applicants was evaluated for the presence of antibody to nucleocapsid protein with an immunoassay intended for qualitative detection of antibodies to SARS-CoV-2 in human serum and plasma (Elecsys Anti–SARS-CoV-2; Roche Diagnostics) at the Clinical Reference Laboratory in Lenexa, Kansas. This test has a reported sensitivity and specificity of 99.5% and 99.8%, respectfully.[2] Applicants' age, sex, state of residence, and antibody status were recorded and all personal data were removed. The Western Institutional Review Board reviewed the study under the Common Rule and applicable guidance and deemed it to be exempt because it uses deidentified study samples for epidemiologic investigation. All participants signed disclosures indicating that results may be used for research purposes. The study conforms to the recommendations of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline.

To estimate the total burden of SARS-CoV-2 infections in the United States, the 2019 estimated US Census population was multiplied by the proportion of the US population between the ages of 16 and 80 years (75.5%), the selected adult portion of the total population. Then, the state-specific proportion of positive test results was applied from our sample. Confidence limits were estimated by generating 5000 bootstrap samples and recalculating the total number of US cases. The χ^2 test and unpaired, 2-tailed *t* test were used to test for differences between seropositive and seronegative

Table 1. SARS-CoV-2 Seroprevalence Rate by Age and Sex as of September 30, 2020

Characteristic	No.	No. (%) Positive	*P* value[a]
Age (categorical), y			
<30	8583	837 (9.8)	<.001
30-39	18 326	1230 (6.7)	
40-49	14 513	972 (6.7)	
50-59	11 630	676 (5.9)	
60-69	7367	321 (4.4)	
≥70	1491	42 (2.8)	
All ages	61 910	4094 (6.6)	
Sex			
Male	34 737	2215 (6.4)	.005
Female	27 173	1883 (6.9)	

Abbreviation: SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

[a] *P* values are based on the χ^2 test.

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Table 2. SARS-CoV-2 Seroprevalence Rate by US State as of September 30, 2020

State	Individuals tested, No.	Rate, %
Alabama	750	7.9
Alaska	85	0
Arkansas	445	4.9
Arizona	900	7.4
California	7459	4.5
Colorado	1212	4.1
Connecticut	869	6.0
Delaware	166	7.2
District of Columbia	136	6.6
Florida	4388	9.3
Georgia	2131	7.8
Hawaii	388	1.8
Idaho	268	5.6
Illinois	2361	5.8
Indiana	1109	5.1
Iowa	592	5.1
Kansas	444	8.1
Kentucky	706	3.4
Louisiana	634	12.0
Maine	155	0.6
Maryland	1212	6.3
Massachusetts	1460	4.2
Michigan	1257	5.5
Minnesota	1167	3.9
Mississippi	630	9.0
Missouri	928	6.1
Montana	128	2.3
North Carolina	2105	3.0
North Dakota	155	2.6
Nebraska	516	4.3
Nevada	469	10.0
New Hampshire	222	2.7
New Jersey	2324	9.5
New Mexico	313	1.9
New York	5020	14.4
Ohio	1741	4.9
Oklahoma	392	5.1
Oregon	512	1.4
Pennsylvania	2155	3.7
Puerto Rico	384	3.9
Rhode Island	185	3.8
South Carolina	874	6.8
South Dakota	178	6.2
Tennessee	1163	6.7
Texas	5737	8.1
Utah	743	3.6
Vermont	88	2.3
Virginia	1855	4.6
Washington	1065	3.8
West Virginia	177	2.3
Wisconsin	1043	4.9
Wyoming	83	2.4
Others, unknown	431	8.1

Abbreviation: SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

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groups as appropriate, with a significance level of 99%. All statistical analyses were performed using R version 3.6.1[3] and RStudio version 1.2.1335 software (R Foundation for Statistical Computing).[4]

Results

A total of 61 910 participants were tested for antibodies to SARS-CoV-2. Among the 4094 seropositive participants, 2215 (54%) were male. The median age of male participants was 39 years (interquartile range [IQR], 31-50 years); for female participants the median age was 39 years (IQR, 31-49 years). Among the 57 816 seronegative participants, 32 377 (56%) were male with a median age of 42 years (IQR, 34-54 years); for the 27 173 seronegative female participants the median age was 41 years (IQR, 33-53 years). The differences in age and sex were both significant (2-sided $P < .001$ for age; 2-sided $P = .005$ for sex). The seroprevalance rate was slightly higher for female than male participants (6.9% compared with 6.4%) and was associated with age; those older than 70 years had the lowest seroprevalence rate (2.8%), and those younger than 30 years (9.8%) had the highest seroprevalence rate (9.8%) (**Table 1**).

The seroprevalence rate varied widely by state (**Table 2**). On the basis of this sample, it was estimated that 15.9 million (bootstrap 95% CI, 15.5-16.5 million) asymptomatic or undiagnosed SARS-CoV-2 infections had occurred in the United States as of September 30, 2020.

Discussion

Other studies of SARS-CoV-2 serologic testing have found a higher implied cumulative prevalence.[5] This difference may be due to unintended bias when testing samples submitted for clinical testing compared with the generally well insurance population. Our estimate implied more than twice the number of infections than cases reported to Centers for Disease Control and Prevention,[6] suggesting a more widespread pandemic. Limitations of the study include self-reported health status (well) and an imbalanced representation of the US population by age, sex, and residence location. Even with these limitations, the study validates the need for ongoing population-wide surveillance.

The findings of this cross-sectional study suggest that, based on a sample from an otherwise healthy population, the overall number of SARS-CoV-2 infections in the US may be substantially higher than estimates based on public health case reporting.

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