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Marked Disparities in COVID-19 Prevalence by Racial/Ethnic, Socioeconomic, Geographic, and Health Care Characteristics, United States, January – April, 2021

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ABSTRACT

Background: Since the start of the coronavirus disease (COVID-19) pandemic in March 2020, racial/ethnic minorities and socially-disadvantaged populations in the United States (US) have experienced disproportionately higher rates of COVID-19 incidence, mortality and hospitalization. However, the extent of disparities in the prevalence of COVID-19 diagnosis have not been well-documented. Using nationally representative data, this study examines racial/ethnic, socioeconomic, and geographic inequalities in COVID-19 prevalence among US adults aged ≥18 years.

Methods: Using the Census Bureau's Household Pulse Survey from January 6-April 26, 2021 (N=521,203), social inequalities in COVID-19 prevalence were analyzed by multivariate logistic regression.

Results: During January-April 2021, 34.7 million or 14.2% of US adults reported ever being diagnosed with COVID-19. Those aged 18-24 and 45-54 were two times more likely to be diagnosed with COVID-19 than those aged ≥75. Disease prevalence ranged from 10.0% for Asians to 14.2% for Black/African Americans and 23.0% for Hispanics. Controlling for covariates, non-Hispanic Whites, Black/African Americans, and Hispanics had, respectively, 23%, 31%, and 134% higher odds of being diagnosed with COVID-19 than Asians. Educational gradients were marked; adults with less than a high school education had twice the prevalence of COVID-19 than those with a graduate degree (19.0% vs. 9.4%). Controlling for covariates, those with less than high school and high school education had, respectively, 66% and 48% higher odds of being diagnosed with COVID-19 than those with a graduate degree. Those experiencing job/income losses during the pandemic had a significantly increased risk of COVID-19 diagnosis, adjusting for other factors. Prevalence of COVID-19 ranged from a low of 7.4% in Seattle-Tacoma Metropolitan Statistical Area (MSA) to a high of 30.0% in Riverside-San Bernardino MSA.

Conclusions and Implications for Translational Research: Black/African Americans, Hispanics, Non-Hispanic Whites, socially-disadvantaged adults, and those living in Riverside-San Bernardino, Phoenix, Dallas-Fort Worth, and Los Angeles-Long Beach MSAs had substantially higher likelihood of being diagnosed with COVID-19.

Key words: • COVID-19 • Social Determinants • Prevalence • Race • Socioeconomic Status • Metropolitan • Disparities • Job Loss

1. Introduction

The novel coronavirus disease (COVID-19) pandemic has had a devastating social, economic, and health impact in the United States (US) and globally, leading to huge job and income losses, increased social isolation, mental health problems, excess premature mortality, and declines in life expectancy and overall well-being.[1–7] As of June 3, 2021, there were 171,222,477 confirmed COVID-19 cases and 3,686,142 deaths worldwide,[2] with the United States bearing the brunt of the pandemic with 33.3 million confirmed cases and 595,833 deaths.[8] The health impact of COVID-19 has been particularly severe on racial/ethnic minorities and vulnerable and underserved populations in the United States. Life expectancy during the first half of 2020 declined by 2.7 years for Black/African Americans, 3.0 for Black males, 1.9 years for Hispanics, and 2.4 years for Hispanic males.[4] As of May 26, 2021, compared with non-Hispanic Whites, the risks of COVID-19 infections, hospitalizations, and mortality were 1.6, 3.3, and 2.4 times higher for American Indians and Alaska Natives (AIANs), 1.1, 2.9, and 1.9 times higher for Black/African Americans, and 2.0, 2.8, and 2.3 times higher for Hispanics.[9]

Although inequalities in COVID-19 incidence and mortality have been reported in the US,[9–12] the extent of racial/ethnic, socioeconomic, and geographic disparities in the prevalence of COVID-19 diagnosis are less well documented.[13] Using a large nationally representative survey, this study examines racial/ethnic, socioeconomic, and geographic inequalities in COVID-19 prevalence among US adults aged ≥18 years during the coronavirus pandemic.

The existing US data show that the COVID-19 pandemic has exacerbated health and health care inequities among the nation's communities of color and socially disadvantaged and underserved populations,[9–12] which have experienced a disproportionate burden in terms of increased infection, hospitalization, mortality, and greater health risks including physical and mental health problems. Reducing health inequalities has continued to be one of the most important goals of the Healthy People initiative and the US Department of Health and Human Services,[14–16] and our study's primary aim of addressing racial/ethnic, socioeconomic, and geographic disparities in COVID-19 diagnosis is consistent with this goal. The study's aim is also in line with the Presidential Executive Orders on COVID-19 that call for (1) addressing factors that have contributed to disparities in COVID-19 outcomes, and (2) developing evidence-based research and equitable public health response for mitigating the health and social inequities caused or exacerbated by the COVID-19 pandemic and for preventing such inequities in the future.[17–19]

2. Methods

2.1. Data

We used pooled data from the seven consecutive rounds of the US Census Bureau's Household Pulse Survey (HPS) conducted from January 6 to April 26, 2021 (phase 3, weeks 22 through 27 and phase 3.1, week 28).[20,21] The HPS is a national sample household survey in which data on socioeconomic, demographic, self-assessed health, mental health, and health care characteristics during the COVID-19 pandemic are collected in near real time via email and internet. All information collected in the survey are based on self-reports. The HPS uses a systematic sample design and is representative of the civilian non-institutionalized population of the United States.

The HPS was developed as a rapid response survey in order to track the social and economic impacts of the COVID-19 pandemic on American households on a weekly or a bi-weekly basis in partnership with 11 federal statistical agencies: Bureau of Labor Statistics, National Center for Health Statistics, United States Department of Agriculture's Economic Research Service, National Center for Education Statistics, Centers for Disease Control and Prevention, Maternal and Child Health Bureau, National Institute for Occupational Safety and Health, Department of Defense, Department of Housing and Urban Development, Social Security Administration, and Bureau of Transportation Statistics.[20–23]

The survey was implemented in four phases.[23] Phase 1 of the HPS was conducted every week

starting April 23, 2020 and ended on July 21, 2020. Data collection for Phase 2 of the HPS began on August 19, 2020 and ended on October 26, 2020. Data Collection for Phase 3 began on October 28, 2020 and ended on March 29, 2021.[21,23] Data Collection for Phase 3.1 began on April 14, 2021 and is scheduled to continue through the beginning of July, 2021.[21] In Phase 1, individuals were asked about their experiences during the pandemic in terms of employment status, food security, housing, physical and mental health, health care access, and educational disruption. Phase 2 included additional questions on the application and receipt of benefits, spending patterns, and availability of financial resources, post-secondary education disruptions, capacity to telework, and travel practices. Phase 3 carries over many of the same questions, but starting with Week 22 additional questions on COVID-19 diagnosis and individuals' intention to receive a COVID-19 vaccine were added.[23]

2.2. Measurement of COVID-19 Prevalence and Covariates

The prevalence of COVID-19 diagnosis was based on the question: *"Has a doctor or other health care provider ever told you that you have COVID-19?"*[20] The responses included "yes", "no", or "not sure". Those responding "yes" were defined as having been diagnosed with COVID-19 and those with "no" response were considered as not having the disease diagnosis. The response "not sure" was excluded from the analysis.

The pooled sample size for the January 6 – April 26, 2021 HPS was 528,148 for adults aged 18 years and older. There were 6,945 (1.31%) observations with missing data or "not sure" response for the COVID-19 diagnosis question, excluding which resulted in an effective sample size of 521,203 for analysis.

Based on the social-determinants-of-health framework and previous research, the following covariates of COVID-19 prevalence were considered: age, gender, race/ethnicity, marital status, region of residence, educational attainment, household income, housing tenure, job/income loss during the pandemic, and health insurance status.[11,15] These variables are measured as shown in Table 1. The other/multiple race group consisted of AIANs, Native Hawaiians and Pacific Islanders, mixed-race individuals, and other races. Additionally, the COVID-19 prevalence was analyzed for the 15 largest Metropolitan Statistical Areas (MSAs) of the US that were available in the sample. The other metropolitan areas were not identified in the public-use file.

2.3. Statistical Analysis

Multivariate logistic regression was used to examine racial/ethnic, socioeconomic, and geographic inequalities in COVID-19 prevalence after controlling for selected socioeconomic and demographic characteristics. The Chi-square statistic was used to test the overall association between each covariate and COVID-19 prevalence, whereas the two-sample *t* test was used to test the difference in prevalence between any two groups or geographic areas. To account for the complex sample design of the HPS, SUDAAN software was used to conduct all statistical analyses, including the logistic modeling procedure RLOGIST.[24] Adjusted COVID-19 prevalence estimates were derived by the logistic model at the mean values of the covariates.

3. Results

3.1. Disparities in Prevalence and Odds of COVID-19 by Race/Ethnicity and Socioeconomic Factors

During January-April 2021, 34.7 million or 14.2% of US adults reported being diagnosed with COVID-19 (data not shown). Those aged 18-24 and 45-54 were two times more likely to be diagnosed with COVID-19 than those aged ≥75 (Table 1). Disease prevalence ranged from 10.0% for Asians to 14.2% for Blacks/African Americans and 23.0% for Hispanics. Educational gradients in prevalence were marked, with adults with less than a high school education having twice the prevalence of COVID-19 than those with a graduate degree (19.0% vs. 9.4%). Adults experiencing household job/income losses during the pandemic had a 32% higher COVID-19 prevalence than those without job/income losses (16.5% vs. 12.5%). Those without health insurance had an 18% higher likelihood of being diagnosed with COVID-19 than those with insurance (15.4% vs. 13.1%).

Table 1: Descriptive Characteristics of the Sample and Unadjusted Weighted Prevalence and Odds of COVID-19 Diagnosis by Socioeconomic and Demographic characteristics, US Adults Aged ≥18 Years: The Household Pulse Survey, Phase 3, Weeks 22-28, January 6-April 26, 2021 (N = 521,203)

Covariates	Total Sample		Unadjusted		Unadjusted		
	Weighted %	SE	Prevalence	SE	OR[1]	95% CI	
Age (years)							
18-24	8.99	0.12	16.87	0.52	2.41	2.12	2.73
25-34	17.50	0.12	15.58	0.30	2.19	1.96	2.45
35-44	17.78	0.11	15.80	0.27	2.23	2.00	2.49
45-54	16.46	0.10	16.22	0.26	2.30	2.06	2.56
55-64	17.49	0.10	14.29	0.24	1.98	1.77	2.21
65-74	15.08	0.09	9.54	0.22	1.25	1.12	1.40
≥75	6.70	0.07	7.77	0.38	1.00	reference	
Gender							
Male	48.32	0.15	13.43	0.17	1.00	reference	
Female	51.68	0.15	14.88	0.14	1.13	1.09	1.17
Race/ethnicity							
Non-Hispanic White	62.80	0.16	12.21	0.11	1.26	1.14	1.38
Non-Hispanic Black	11.44	0.11	14.20	0.34	1.49	1.34	1.67
Asian	5.27	0.07	9.97	0.43	1.00	reference	
Other and multiple race	3.60	0.06	13.22	0.55	1.37	1.20	1.57
Hispanic	16.89	0.14	23.02	0.41	2.70	2.43	3.00
Marital status							
Married	55.45	0.15	13.96	0.13	1.00	reference	
Widowed	4.30	0.05	10.98	0.42	0.76	0.70	0.83
Divorced/separated	13.48	0.10	14.64	0.31	1.06	1.00	1.12
Single	26.77	0.15	14.95	0.26	1.08	1.03	1.13
Geographic region							
Northeast	17.15	0.12	12.82	0.26	1.00	reference	
South	38.23	0.15	14.96	0.19	1.20	1.13	1.26
Midwest	20.66	0.11	14.45	0.20	1.15	1.09	1.22
West	23.96	0.13	13.68	0.25	1.08	1.01	1.15
Education (years of school completed)							
Less than high school (<12)	8.55	0.13	19.04	0.65	2.27	2.07	2.48
High school (12)	30.34	0.16	14.81	0.25	1.68	1.59	1.76
Some college (13-15)	30.52	0.12	15.33	0.17	1.74	1.67	1.82
College degree (16)	17.29	0.08	12.32	0.15	1.35	1.30	1.41
Graduate degree or higher (≥17)	13.29	0.07	9.40	0.14	1.00	reference	
Household income in 2019 ($)							
<25,000	9.98	0.10	13.42	0.40	1.47	1.34	1.61
25,000-34,999	7.73	0.08	14.37	0.40	1.59	1.46	1.74
35,000-49,999	8.86	0.09	14.38	0.37	1.60	1.47	1.74
50,000-74,999	12.56	0.09	14.04	0.29	1.55	1.44	1.68
75,000-99,999	9.18	0.08	12.84	0.29	1.40	1.29	1.51

(Contd...)

Table 1: ***(Continued)***

Covariates	Total Sample		Unadjusted		Unadjusted		
	Weighted %	SE	Prevalence	SE	OR[1]	95% CI	
100,000-149,999	10.65	0.08	12.33	0.24	1.34	1.24	1.44
150,000-199,999	4.93	0.05	11.80	0.35	1.27	1.16	1.39
≥200,000	5.47	0.05	9.52	0.27	1.00	reference	
Unknown	30.64	0.15	16.65	0.24	1.90	1.77	2.03
Housing tenure							
Owner	72.09	0.16	12.66	0.13	1.00	reference	
Renter	27.91	0.16	14.53	0.25	1.17	1.12	1.23
Job/income loss since start of pandemic							
Yes	42.71	0.15	16.47	0.19	1.38	1.33	1.43
No	57.29	0.15	12.49	0.13	1.00	reference	
Health insurance status							
Insured	91.76	0.12	13.06	0.12	1.00	reference	
Not insured	8.24	0.12	15.40	0.55	1.21	1.11	1.32

SE= standard error. OR=odds ratio; CI=confidence interval. [1]ORs estimated by logistic model were unadjusted for the effects of other covariates. Chi-square statistics for testing the overall association between each covariate and prevalence of COVID-19 were statistically significant at P<0.001

Age, gender, race/ethnicity, education, household income, marital status, region of residence, health insurance, and household job/income loss during the pandemic were independent and significant predictors of COVID-19 diagnosis (Table 2). Those aged 18-24 and 45-54 had, respectively, 2.2 and 2.1 times higher adjusted odds of being diagnosed with COVID-19 than those aged ≥75 (Table 2). Controlling for covariates, non-Hispanic Whites, Blacks, and Hispanics had, respectively, 23%, 31%, and 134% higher adjusted odds of being diagnosed with COVID-19 than Asians. Controlling for covariates, those with less than a high school or high school education had, respectively, 66% and 48% higher odds of being diagnosed with COVID-19 than those with a graduate degree. Those experiencing household job/income losses during the pandemic had 18% higher odds of COVID-19 diagnosis than those without job/income losses, adjusting for other factors (Table 2).

3.2. Joint Effects of Age, Race/Ethnicity, and Education on COVID-19 Prevalence

Race-specific prevalence differed by age, with Asians reporting the lowest rate of COVID-19 prevalence and Hispanics, non-Hispanic Whites and Blacks reporting the highest prevalence for age groups 18-64 and ≥65 years. The prevalence of COVID-19 ranged 3-fold, from 7.3% for Asian aged ≥65 to 16.0% for Hispanics aged ≥65 and 23.9% for Hispanics aged 18-64 (Table 3). Educational gradients in prevalence were pronounced for both age groups; adults aged 18-64 with less than a high school education had 89% higher likelihood of being diagnosed and adults aged ≥65 had 166% higher likelihood of being diagnosed, compared to their counterparts with a graduate degree. Adults aged 18-64 years with less than a high school education had 3.5 times higher COVID-19 prevalence than those aged ≥65 years with a graduate degree (20.0% vs 5.8%) (Table 3).

Educational patterns in COVID-19 prevalence varied by race. Although lower educational attainment was generally associated with higher COVID-19 prevalence in all groups, educational gradients in prevalence were more consistent and pronounced for Asians, Hispanics and the other/multiple-race group (Table 3). For example, Hispanics with less than a high school education had a COVID-19 prevalence of 26.6%, 83% higher than the prevalence of 14.5% for Hispanics with a graduate degree. Asians with less than a high school education had a COVID-19 prevalence of 15.7%, 192% higher than

Table 2: Covariate-Adjusted Odds and Prevalence of COVID-19 Diagnosis by Socioeconomic and Demographic characteristics, US Adults Aged ≥18 Years: The Household Pulse Survey, Phase 3, Weeks 22-28, January 6 – April 26, 2021 (N = 521,203)

Covariates	Adjusted Model[1]			Adjusted[1]	
	OR	95%	CI	Prevalence	SE
Age (years)					
18-24	2.18	1.88	2.53	16.33	0.56
25-34	2.08	1.83	2.36	15.73	0.32
35-44	2.06	1.82	2.32	15.58	0.26
45-54	2.10	1.86	2.36	15.84	0.26
55-64	1.85	1.64	2.07	14.24	0.24
65-74	1.21	1.08	1.36	9.90	0.24
≥75	1.00	reference		8.32	0.43
Gender					
Male	1.00	reference		13.29	0.17
Female	1.16	1.12	1.20	15.04	0.15
Race/ethnicity					
Non-Hispanic White	1.23	1.12	1.36	12.63	0.12
Non-Hispanic Black	1.31	1.17	1.47	13.33	0.33
Asian	1.00	reference		10.53	0.46
Other and multiple race	1.25	1.09	1.43	12.81	0.54
Hispanic	2.34	2.10	2.60	21.36	0.38
Marital status					
Married	1.00	reference		14.75	0.16
Widowed	0.98	0.89	1.08	14.51	0.58
Divorced/separated	0.99	0.93	1.04	14.59	0.32
Single	0.86	0.82	0.91	13.02	0.25
Geographic region					
Northeast	1.00	reference		13.38	0.27
South	1.13	1.07	1.19	14.79	0.18
Midwest	1.18	1.12	1.25	15.41	0.22
West	0.95	0.9	1.01	12.84	0.22
Education (years of school completed)					
Less than high school (<12)	1.66	1.51	1.83	16.27	0.58
High school (12)	1.48	1.40	1.56	14.79	0.25
Some college (13-15)	1.52	1.45	1.58	15.06	0.16
College degree (16)	1.26	1.21	1.32	12.92	0.17
Graduate degree or higher (≥17)	1.00	reference		10.55	0.17
Household income in 2019 ($)					
<25,000	1.03	0.93	1.14	12.53	0.41
25,000-34,999	1.17	1.06	1.29	13.96	0.41
35,000-49,999	1.22	1.11	1.34	14.46	0.40
50,000-74,999	1.24	1.14	1.35	14.65	0.33
75,000-99,999	1.17	1.08	1.27	13.97	0.35

(Contd...)

Table 2: ***(Continued)***

Covariates	Adjusted Model[1]			Adjusted[1]	
	OR	95%	CI	Prevalence	SE
100,000-149,999	1.17	1.09	1.27	13.97	0.33
150,000-199,999	1.18	1.07	1.29	14.00	0.46
≥200,000	1.00	reference		12.20	0.39
Unknown	1.27	1.15	1.41	14.94	0.34
Housing tenure					
Owner	1.00	reference		13.92	0.25
Renter	0.99	0.94	1.04	13.76	0.32
Job/income loss since start of pandemic					
Yes	1.18	1.14	1.23	15.29	0.18
No	1.00	reference		13.27	0.15
Health insurance status					
Insured	1.00	reference		14.20	0.20
Not insured	0.86	0.79	0.94	12.52	0.48

SE= standard error. OR=odds ratio; CI=confidence interval. [1]Adjusted by logistic regression model for age, gender, race/ethnicity, marital status, region of residence, education, household income, housing tenure, job/income loss, and insurance status

the prevalence of 5.4% for Asians with a graduate degree. As for the full range of race-education disparities, the COVID-19 prevalence varied almost 5-fold, from a low of 5.4% for Asians with a graduate degree to a high of 26.6% for Hispanics with less than a high school education (Table 3).

3.3. Disparities in COVID-19 Prevalence among Large Metropolitan Areas

Among the 15 available largest metropolitan areas in the sample, prevalence of COVID-19 ranged from a low of 7.4% in Seattle-Tacoma and 8.3% in San Francisco-Oakland MSAs to a high of 18.3% in Phoenix-Mesa and 22.0% in Riverside-San Bernardino MSAs (Figure 1). For Hispanics living in Phoenix-Mesa, Los Angeles-Long Beach, and Riverside-San Bernardino MSAs, the COVID-19 prevalence was 28.0%, 28.6%, and 30.6% respectively (Table 4). For non-Hispanic Blacks in the Riverside-San Bernardino and Boston-Cambridge MSAs, the COVID-19 prevalence was 17.1% and 17.2% respectively (Table 4). For adults with less a high school education, the COVID-19 prevalence was 28.7% in Riverside-San Bernardino and 29.1% in Phoenix-Mesa MSAs. For adults with household income <$25,000, the COVID-19 prevalence was 24.7% in Riverside-San Bernardino.

Age, gender, race/ethnicity, education, household income, marital status, and job/income loss were independent and significant predictors of COVID-19 prevalence in metropolitan areas. After controlling for socioeconomic and demographic characteristics, compared with Seattle-Tacoma MSA, the odds of COVID-19 diagnosis were 2.4 times higher (OR=2.36; 95% CI=1.98-2.82) for Riverside-San Bernardino, 2.3 times higher for Dallas-Fort Worth (OR=2.28; 95% CI=1.93-2.71), and 2.3 times higher (OR=2.33; 95% CI=1.97-2.75) for Phoenix -Mesa MSA. Both adjusted and unadjusted rates of COVID-19 prevalence were significantly higher for all metropolitan areas except for San Francisco-Oakland MSA, compared with the Seattle-Tacoma MSA (Figure 1).

4. Discussion

In this study, we have analyzed inequalities in COVID-19 prevalence in the US by major social determinants such as race/ethnicity, education, income, employment/income loss during the pandemic, region and metropolitan area of residence. During January-April 2021, 34.7 million or 14.2% of US adults reported being diagnosed with COVID-19. Those aged 18-24 and 45-54 were two times more likely to be diagnosed with COVID-19

Table 3: Joint Prevalence of COVID-19 Diagnosis by Age, Race/Ethnicity, and Educational Attainment, US Adults Aged ≥18 Years: The Household Pulse Survey, January 6 - April 26, 2021 (N = 521,203)

Covariates	Unadjusted[1]		Prevalence Rate Ratio[1]		
	Prevalence	SE	RR	95% CI	
Age X race/ethnicity					
Non-Hispanic White, Age 18-64	13.66	0.14	1.31	1.19	1.43
Non-Hispanic Black, Age 18-64	15.23	0.38	1.46	1.31	1.61
Asian, Age 18-64	10.41	0.48	1.00	reference	
Other/multiple race, Age 18-64	13.61	0.54	1.31	1.15	1.46
Hispanic, Age 18-64	23.94	0.44	2.30	2.08	2.52
Non-Hispanic White, Age 65+	8.16	0.16	1.11	0.83	1.39
Non-Hispanic Black, Age 65+	9.08	0.66	1.24	0.88	1.59
Asian, Age 65+	7.34	0.94	1.00	reference	
Other/multiple race, Age 65+	11.08	1.99	1.51	1.05	1.97
Hispanic, Age 65+	16.03	1.24	2.18	1.54	2.82
Age X educational attainment (years)					
Less than high school (12), Age 18-64	19.95	0.71	1.89	1.74	2.03
High school (12), Age 18-64	16.56	0.31	1.57	1.49	1.64
Some college (13-15), Age 18-64	16.89	0.20	1.60	1.53	1.66
College degree (16), Age 18-64	13.45	0.18	1.27	1.22	1.33
Graduate degree or higher (≥17), Age 18-64	10.58	0.18	1.00	reference	
Less than high school (<12), Age 65+	15.29	1.60	2.66	2.09	3.23
High school (12), Age 65+	10.02	0.34	1.74	1.59	1.90
Some college (13-15), Age 65+	8.66	0.19	1.51	1.40	1.61
College degree (16), Age 65+	6.89	0.20	1.20	1.10	1.30
Graduate degree or higher ((≥17)), Age 65+	5.75	0.17	1.00	reference	
Race/ethnicity X educational attainment (years)					
Less than high school (<12), NH White	11.75	0.78	1.30	1.13	1.47
High school (12), NH White	12.51	0.26	1.38	1.31	1.46
Some college (13-15), NH White	13.92	0.18	1.54	1.48	1.6
College degree, (16) NH White	11.50	0.16	1.27	1.22	1.33
Graduate degree or higher (≥17), NH White	9.04	0.15	1.00	reference	
Less than high school (<12), NH Black	14.00	1.71	1.21	0.90	1.52
High school (12), NH Black	14.24	0.72	1.23	1.06	1.4
Some college (13-15), NH Black	14.96	0.46	1.29	1.15	1.44
College degree (16), NH Black	14.62	0.60	1.26	1.11	1.42
Graduate degree or higher (≥17), NH Black	11.58	0.55	1.00	reference	
Less than high school (<12), Asian	15.67	2.69	2.92	1.87	3.96
High school (12), Asian	13.50	1.56	2.51	1.86	3.16
Some college (13-15), Asian	11.44	0.85	2.13	1.72	2.54
College degree (16), Asian	9.15	0.48	1.70	1.43	1.98
Graduate degree or higher (≥17), Asian	5.37	0.34	1.00	reference	
Less than high school (<12), other/multiple race	21.13	3.70	2.01	1.21	2.8

(Contd...)

Table 3: ***(Continued)***

Covariates	Unadjusted[1]		Prevalence Rate Ratio[1]		
	Prevalence	SE	RR	95% CI	
High school (12), other/multiple race	11.97	0.99	1.14	0.84	1.43
Some college (13-15), other/multiple race	13.43	0.66	1.28	0.99	1.56
College degree (16), other/multiple race	12.50	0.99	1.19	0.89	1.49
Graduate degree or higher (≥17), other/multiple race	10.53	1.08	1.00	reference	
Less than high school (<12), Hispanic	26.56	1.16	1.83	1.60	2.06
High school (12), Hispanic	23.91	0.82	1.65	1.46	1.84
Some college (13-15), Hispanic	22.84	0.59	1.58	1.41	1.74
College degree (16), Hispanic	18.55	0.68	1.28	1.13	1.43
Graduate degree or higher (≥17), Hispanic	14.48	0.68	1.00	reference	

SE= standard error; RR=rate ratio; NH=Non-Hispanic; CI=confidence interval. [1]Unadjusted for the effects of other covariates

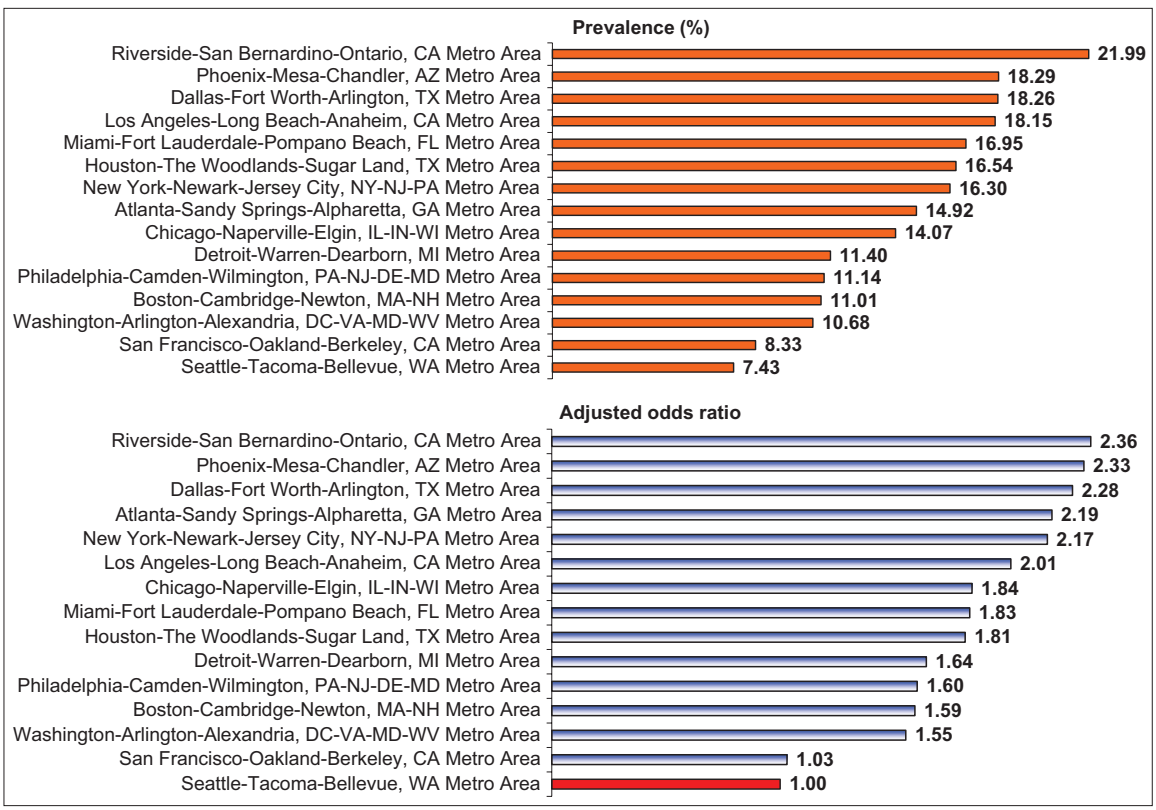

Figure 1: Prevalence[1] and Adjusted[2] Odds Ratios for COVID-19 Diagnosis among Adults Aged ≥18 Years in 15 Largest Metropolitan Statistical Areas (MSAs), United States, January 6 – April 26, 2021

Notes: [1]Prevalence estimates for all MSAs except San Francisco-Oakland MSA were significantly higher than the prevalence for Seattle-Tacoma MSA at P<0.05. [2]Adjusted by logistic regression for age, gender, race/ethnicity, marital status, education, household income, housing tenure, job/income loss, and insurance status. All adjusted odds ratios except for San Francisco-Oakland MSA were statistically significant at P<0.05. **Source:** Data derived from January 6-April 26, 2021 Household Pulse Survey

Table 4: Prevalence[1] of COVID-19 Diagnosis in 15 Largest Metropolitan Statistical Areas (MSAs) by Race/Ethnicity, Educational Attainment, and Household Income US Adults Aged ≥18 Years: The Household Pulse Survey, January 6 - April 26, 2021 (N = 174,845)

Metropolitan area	Non-Hispanic White		Non-Hispanic Black		Asian		Hispanic	
	Prevalence	SE	Prevalence	SE	Prevalence	SE	Prevalence	SE
Atlanta-Sandy Springs-Alpharetta, GA	14.81	0.77	14.54	1.28	11.66	2.47	19.03	2.27
Boston-Cambridge-Newton, MA-NH	9.08	0.49	17.19	2.91	6.11	1.37	23.55	2.37
Chicago-Naperville-Elgin, IL-IN-WI	11.78	0.57	12.64	1.59	9.14	1.56	22.70	1.76
Dallas-Fort Worth-Arlington, TX	14.74	0.78	16.48	1.66	11.67	2.15	27.40	1.99
Detroit-Warren-Dearborn, MI	10.63	0.63	12.81	1.49	13.51	3.14	18.33	3.24
Houston-The Woodlands-Sugar Land, TX	11.96	0.81	10.56	1.13	10.87	2.00	24.86	1.64
Los Angeles-Long Beach-Anaheim, CA	9.88	0.77	8.07	1.55	10.00	1.24	28.62	1.48
Miami-Fort Lauderdale-Pompano Beach, FL	10.24	0.95	12.99	2.19	4.91	1.76	24.08	1.39
New York-Newark-Jersey City, NY-NJ-PA	13.88	0.72	13.58	1.48	8.64	1.02	26.82	1.70
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	9.65	0.49	13.03	1.36	13.00	2.75	17.42	2.02
Phoenix-Mesa-Chandler, AZ	14.21	0.73	15.06	2.55	14.69	3.47	28.01	1.78
Riverside-San Bernardino-Ontario, CA	13.62	0.9	17.09	3.21	13.99	2.21	30.56	1.66
San Francisco-Oakland-Berkeley, CA	4.07	0.47	10.97	4.31	5.65	0.72	17.02	1.97
Seattle-Tacoma-Bellevue, WA	5.54	0.49	5.07	1.22	9.92	1.70	17.68	2.25
Washington-Arlington-Alexandria, DC-VA-MD-WV	7.13	0.51	12.57	1.02	10.14	1.44	21.03	1.81
	<High school		≥Graduate degree		Income <$25,000		Income ≥$200,000	
	Prevalence	SE	Prevalence	SE	Prevalence	SE	Prevalence	SE
Atlanta-Sandy Springs-Alpharetta, GA	14.22	3.02	12.15	0.97	10.78	2.19	12.77	1.90
Boston-Cambridge-Newton, MA-NH	12.30	2.74	5.71	0.45	11.64	1.83	5.79	0.81
Chicago-Naperville-Elgin, IL-IN-WI	18.58	2.79	8.66	0.60	10.94	1.98	11.12	1.45
Dallas-Fort Worth-Arlington, TX	24.55	3.02	14.78	1.21	16.31	2.72	14.72	1.75
Detroit-Warren-Dearborn, MI	14.99	3.15	8.87	0.84	11.76	2.34	10.32	2.33
Houston-The Woodlands-Sugar Land, TX	21.35	2.79	9.22	0.84	19.84	3.14	9.72	1.15
Los Angeles-Long Beach-Anaheim, CA	27.69	2.88	7.81	0.69	18.36	2.27	7.44	0.97
Miami-Fort Lauderdale-Pompano Beach, FL	23.75	3.98	11.27	0.99	16.60	2.38	8.28	1.69
New York-Newark-Jersey City, NY-NJ-PA	19.41	2.78	10.03	0.63	13.91	2.31	12.46	1.22
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	15.23	3.07	7.24	0.61	15.63	2.44	8.77	1.20
Phoenix-Mesa-Chandler, AZ	29.14	4.01	11.27	0.86	19.21	2.97	11.75	1.65
Riverside-San Bernardino-Ontario, CA	28.74	3.27	13.19	1.19	24.69	3.50	13.24	2.52
San Francisco-Oakland-Berkeley, CA	19.83	3.76	4.62	0.65	10.42	2.63	3.39	0.57
Seattle-Tacoma-Bellevue, WA	13.07	3.17	4.46	0.8	9.23	2.26	2.36	0.51
Washington-Arlington-Alexandria, DC-VA-MD-WV	16.96	2.81	5.69	0.43	15.10	2.21	5.25	0.69

SE= standard error. [1]Unadjusted for the effects of other covariates

than those aged ≥75. Stratification by race/ethnicity and socioeconomic status (SES) revealed marked inequalities in COVID-19 prevalence for the total US population as well as for the 15 largest metropolitan areas. As for the full range of race-education disparities, the COVID-19 prevalence varied more than 5-fold, from a low of 5.4% for Asians with a graduate degree to a high of 26.6% for Hispanics with less than a high school education. Low-education and low-income adults in metropolitan areas such as Phoenix and Riverside-San Bernardino were 6 to 10 times more likely to be diagnosed with COVID-19 than their high-education and high-income counterparts in Seattle. In Riverside-San Bernardino and Phoenix metropolitan areas, 1 in 4 low-SES adults reported being diagnosed with COVID-19.

Although variations in COVID-19 incidence and mortality rates in the US have been previously reported,[9–12] no study to our knowledge has analyzed inequalities in the disease prevalence by major social determinants at the national level using multivariate analyses. Additionally, our study makes a unique contribution to the COVID-19 research by identifying racial/ethnic and socioeconomic disparities in COVID-19 both at the national level and in the 15 largest metropolitan areas of the US.

The COVID-19 pandemic has disproportionately affected ethnic-minority and socially-disadvantaged groups in terms of increased mortality, incidence, and hospitalization,[9–12] and the evidence presented here shows a similarly increased risk of diagnosis. The prevalence measure used in our study is a function of both incidence (new infections) and patient mortality/survival. Racial/ethnic and SES disparities in prevalence appear to be smaller than those in COVID-19 incidence rates, as ethnic-minorities and lower-SES individuals diagnosed with the disease experienced significantly higher mortality rates during the 10-month course of the pandemic.[9–12] Social inequalities in COVID-19 prevalence are similar to those found in other health and disease outcomes such as cardiovascular disease, hypertension, obesity, diabetes, HIV/AIDS, and other infectious diseases.[15,16,25–27]

Racial/ethnic, socioeconomic, and geographic disparities in COVID-19 prevalence shown here may partly reflect differences in social distancing, face mask use, handwashing, transport difficulties, lower access to broadband internet and computers and inability to telework, and unfavorable social and economic circumstances that might expose individuals to greater risks of infection during the pandemic. Recent studies have found that wearing masks or social distancing vary by race/ethnicity, SES, and other demographic factors. Adults with some college education or college graduates were more likely to wear a face mask in public, compared with those with high school education.[28,29] Compared with non-Hispanic Whites, non-Hispanic Blacks, Hispanics, and Asians are more likely to wear a mask in response to the COVID-19 pandemic.[29,30] The uptake of face masks is higher among the older age groups, but appear to be lower among higher income groups.[29]

Regarding social distancing, individuals in low-income or poor neighborhoods have been shown to practice social distancing at lower rates during the pandemic than those in high-income or wealthy neighborhoods.[31,32] While Asians are more likely to exhibit social distancing during the pandemic, Blacks are less likely to practice social distancing than non-Hispanic Whites and other racial/ethnic groups.[31,33] Adults aged 18-24 and 25-44 years, adults with lower incomes, Blacks, Hispanics, and other/multiple-race group reported lower rates of handwashing or hand sanitizer use after contact with high-touch public surfaces during the pandemic, compared with those aged ≥45 years, those with higher incomes, Asians, and non-Hispanic Whites, respectively.[34]

4.1. Limitations

This study has limitations. HPS does not collect information on a number of risk factors that could help explain disparities in COVID-19 prevalence such as stress, social isolation, face mask use, social or physical distancing, lack of social support or connectedness, poor diet, physical inactivity, smoking, and alcohol consumption.[35] Second, ethnic detail in the public use file is limited as we are unable to identify AIANs and specific Asian/Pacific Islander and Hispanic subgroups who may be at greater risk of COVID-19 infection.

Information is also lacking on immigrant groups who may be vulnerable to economic hardships and adverse health outcomes during the pandemic. Third, HPS is a cross-sectional survey; causality cannot be inferred, especially for the association of SES with COVID-19 diagnosis. However, educational-level disparities in COVID-19 prevalence are less likely to be affected by reverse causality as formal education is generally attained by age 25 by most individuals and is fairly stable over the life course.[36] Household income in HPS was measured as of 2019, and job and income losses in HPS were measured since the beginning of the pandemic in March 2020, and most likely precede the COVID-19 diagnosis in temporality. Fourth, the respondents in HSP are more likely to be women and non-Hispanic Whites and have higher education, compared with the American Community Survey.[37] This might have resulted in an underestimate of the magnitude of racial/ethnic and SES disparities in COVID-19 prevalence. However, we addressed disproportionate sampling of demographic characteristics by using survey weights, which rakes the demographics of the interviewed persons to education attainment/sex/age distributions and ethnicity/race/sex/age population distributions.[22] Lastly, ethnic-minorities and adults with lower SES have significantly lower broadband internet and computer access in the US and are less likely to have participated in the internet-based HPS, which might have contributed to an underestimate of social inequalities in COVID-19 prevalence shown here.[38]

5. Conclusions and Implications for Translational Research

Based on the analysis of the latest census data, this study has found large disparities in COVID-19 prevalence by such social determinants as race/ethnicity, SES, and metropolitan area in the US. During January-April 2021, 35 million or 1 in 7 US adults reported being diagnosed with COVID-19. Blacks/African American, Hispanics, Non-Hispanic Whites, socially-disadvantaged adults, and those living in Riverside-San Bernardino, Phoenix, Dallas-Fort Worth, and Los Angeles-Long Beach metropolitan areas had substantially higher likelihood of being diagnosed with COVID-19. In some metropolitan areas such as Riverside-San Bernardino and Phoenix, more than 28% of Hispanics and individuals with low educational attainment report being diagnosed with COVID-19.

Mitigation efforts should continue to focus on the socially-disadvantaged and vulnerable populations in order to reduce health inequities in COVID-19 outcomes. Vaccination and prevention efforts including mask-wearing and social distancing measures remain effective measures for controlling and reducing the transmission of COVID-19 and related inequities in morbidity and mortality.

Compliance with Ethical Standards

Conflicts of Interest: *The authors declare that they have no conflict of interest.* ***Financial Disclosure:*** *None to report.* ***Funding/Support:*** *None.* ***Ethical approval:*** *No IRB approval was required for this study, which is based on the secondary analysis of a public-use federal database.* ***Acknowledgments:*** *None.* ***Disclaimer:*** *The views expressed are the authors' and not necessarily those of their institutions.*

Key Messages

- During January-April 2021, 34.7 million or 14.2% of US adults aged ≥18 years reported being diagnosed with COVID-19.
- COVID-19 prevalence ranged from 9.5% for Asians to 13.0% for Non-Hispanic Whites, 13.2% for Blacks/African Americans, and 23.1% for Hispanics.
- Nearly 1 in 5 US adults with less than a high school education had been diagnosed with COVID-19, compared with 1 in 10 adults with a graduate degree.
- Low-education and low-income adults in Riverside-San Bernardino and Phoenix metropolitan areas were 6 to 10 times more likely to be diagnosed with COVID-19 than their high-education and high-income counterparts in the Seattle metropolitan area. In Riverside-San Bernardino and Phoenix metropolitan areas, more than 1 in 4 low-SES adults reported being diagnosed with COVID-19, with the prevalence exceeding 28% for Hispanics and those with less than a high school education.
- Vaccination and prevention efforts including mask-wearing and social distancing continue to be effective measures for controlling and reducing the transmission of COVID-19 and related inequities in morbidity and mortality.

References

1. World Health Organization (WHO). Impact of COVID-19 on people's livelihoods, their health and our food systems. https://www.who.int/news/item/13-10-2020-impact-of-covid-19-on-people's-livelihoods-their-health-and-our-food-systems. Accessed June 3, 2021.
2. World Health Organization (WHO). Coronavirus disease (COVID-19) pandemic. https://www.who.int/emergencies/diseases/novel-coronavirus-2019. Accessed June 3, 2021.
3. International Labour Organization (ILO) and Organisation for Economic Co-operation and Development (OECD). The impact of the COVID-19 pandemic on jobs and incomes in G20 economies. G20 Saudi Arabia 2020. https://www.ilo.org/wcmsp5/groups/public/---dgreports/---cabinet/documents/publication/wcms_756331.pdf. Accessed June 3, 2021.
4. Arias E, Tejada-Vera B, Ahmad F. Provisional life expectancy estimates for January through June, 2020. *Vital Statistics Rapid Release*; no 10. 2021; February 2021. DOI: https://dx.doi.org/10.15620/cdc:100392.
5. Pew Research Center. *Economic Fallout from COVID-19 Continues to Hit Lower-Income Americans the Hardest*. September 2020.
6. Kaiser Family Foundation (KFF). *The Implications of COVID-19 for Mental Health and Substance Use*. Feb 2021. https://www.kff.org/coronavirus-covid-19/issue-brief/the-implications-of-covid-19-for-mental-health-and-substance-use/#:~:text=The%20KFF%20Health%20Tracking%20Poll,eating%2C%20increases%20in%20alcohol%20consumption. Accessed June 3, 2021.
7. Pifarré i Arolas H, Acosta E, López-Casasnovas G. Years of life lost to COVID-19 in 81 countries. *Sci Rep*. 2021;11:3504. https://doi.org/10.1038/s41598-021-83040-3.
8. Johns Hopkins University and Medicine. Coronavirus Resource Center. *United States COVID-19 Overview*. https://coronavirus.jhu.edu/region/united-states. Accessed June 3 2021.
9. Centers for Disease Control and Prevention (CDC). COVID-19: Risk for COVID-19 Infection, Hospitalization, and Death by Race/Ethnicity; February 18, 2021. https://www.cdc.gov/coronavirus/2019-ncov/covid-data/investigations-discovery/hospitalization-death-by-race-ethnicity.html.
10. Karmakar M, Lantz PM, Tipirneni R. Association of social and demographic factors with COVID-19 incidence and death rates in the US. *JAMA Network Open*. 2021;4(1):e2036462. doi:10.1001/jamanetworkopen.2020.36462.
11. Leidman E, Duca LM, Omura JD, Lane RI, Petrosky E, et al. COVID-19 Trends Among Persons Aged 0–24 Years — United States, March 1–December 12, 2020. 13 January 2021. *MMWR*. 2021;70:1-7.
12. Munoz-Price LS, Nattinger AB, Rivera F et al. Racial Disparities in Incidence and Outcomes Among Patients With COVID-19. *JAMA Network Open*. 2020;3(9):e2021892. doi:10.1001/jamanetworkopen.2020.21892.
13. US Census Bureau. Week 28 Household Pulse Survey: April 14 – April 26: Health Tables. https://www.census.gov/data/tables/2021/demo/hhp/hhp28.html#tables. Accessed June 3, 2021.
14. US Department of Health and Human Services. *Healthy People 2030: Building a Healthier Future for All*. Available at: https://health.gov/healthypeople. Accessed 22 February, 2021.
15. Singh GK, Daus GP, Allender M, et al. Social determinants of health in the United States: addressing major health inequality trends for the nation, 1935-2016. *Int J MCH AIDS*. 2017;6(2):139-164.
16. US Department of Health and Human Services. Health Resources and Services Administration. Office of Health Equity. *Health Equity Report, 2019-2020: Special Feature on Housing and Health Inequalities*. 2020. Rockville, Maryland. https://www.hrsa.gov/sites/default/files/hrsa/health-equity/HRSA-health-equity-report.pdf. Accessed June 3, 2021.
17. The White House. *Executive Order on Ensuring an Equitable Pandemic Response and Recovery. Washington, DC*. https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/21/executive-order-ensuring-an-equitable-pandemic-response-and-recovery/. January 2021. Accessed June 3, 2021.
18. The White House. *Executive Order on Ensuring a Data-Driven Response to COVID-19 and Future High-Consequence Public Health Threats*. Washington, DC. https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/21/executive-order-ensuring-a-data-driven-response-to-covid-19-and-future-high-consequence-public-health-threats/. January 2021. Accessed June 3, 2021.
19. The White House. *Executive Order on Advancing Racial Equity and Support for Underserved Communities Through the Federal Government*. Washington, DC. https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/20/executive-order-advancing-racial-equity-and-support-for-underserved-communities-through-the-federal-government/. January 2021. Accessed June 3, 2021.
20. US Census Bureau. Household Pulse Survey Data Dictionary for SAS - Phase 3 and Phase 3.1, Week 22-28, January 6-April 26, 2021. https://www.census.gov/programs-surveys/household-pulse-survey/datasets.html. Accessed June 3, 2021.
21. US Census Bureau. Measuring Household Experiences during the Coronavirus Household Pulse Survey – Phase 3.1. 2021. https://www.census.gov/data/experimental-data-products/household-pulse-survey.html. Accessed June 3, 2021.

22. Fields JF, Hunter-Childs J, Tersine A, et al. Design and operation of the 2020 Household Pulse Survey. *US Census Bureau*. 2020; Forthcoming. https://www2.census.gov/programs-surveys/demo/technical-documentation/hhp/2020_HPS_Background.pdf.

23. US Census Bureau. Technical Documentation: Source of the Data and Accuracy of the Estimates for the Household Pulse Survey – Phase 3; 2021. https://www2.census.gov/programs-surveys/demo/technical-documentation/hhp/Phase3_Source_and_Accuracy_Week_22.pdf. Accessed June 3, 2021.

24. SUDAAN: Software for the Statistical Analysis of Correlated Data, Release 11.0.3. Research Triangle Park, NC: Research Triangle Institute; 2018.

25. Singh GK, Siahpush M, Azuine RE, Williams SD. Widening socioeconomic and racial disparities in cardiovascular disease mortality in the United States, 1969-2013. *Int J MCH AIDS*. 2015; 3(2):106-118.

26. Singh GK, Siahpush M, Azuine RE, Williams SD. Increasing area deprivation and socioeconomic inequalities in heart disease, stroke, and cardiovascular disease mortality among working age populations, United States, 1969-2011. *Int J MCH AIDS*. 2015; 3(2):119-133.

27. National Center for Health Statistics. *Health, United States, 2018*. Hyattsville, MD: US Department of Health and Human Services; 2019.

28. Anderson KM, Stockman JK. Staying Home, Distancing, and Face Masks: COVID-19 Prevention among US Women in The COPE Study. *Int J Environ Res Public Health*. 2021;18(1):180.

29. Gallup. *Americans' Face Mask Usage Varies Greatly by Demographics*. July 2020.

30. Hearne BN, Niño MD. Understanding How Race, Ethnicity, and Gender Shape Mask-Wearing Adherence During the COVID-19 Pandemic: Evidence from the COVID Impact Survey. *J Racial Ethn Health Disparities*. 2021:1-8.

31. Brookings Institution. *Social Distancing in Black and White Neighborhoods in Detroit: A Data-driven Look at Vulnerable Communities*. May 2020.

32. Weill JA, Stigler M, Deschenes O, Springborn MR. Social distancing responses to COVID-19 emergency declarations strongly differentiated by income. *Proc Natl Acad Sci*. 2020;117(33):19658-19660.

33. Pedersen MJ, Favero N. Social Distancing during the COVID-19 Pandemic: Who Are the Present and Future Noncompliers? *Public Adm Rev*. 2020;80(5):805-814.

34. Czeisler ME, Garcia-Williams AG, Molinari N, et al. Demographic characteristics, experiences, and beliefs associated with hand hygiene among adults during the COVID-19 pandemic — United States, June 24–30, 2020. *MMWR*. 2020;69(41):1485-1491.

35. de Frel DL, Atsma DE, Pijl H, et al. The impact of obesity and lifestyle on the immune system and susceptibility to infections such as COVID-19. *Front Nutr*. 2020; 7:597600. doi: 10.3389/fnut.2020.597600.

36. Singh GK, Lee H. Marked Disparities in Life Expectancy by Education, Poverty Level, Occupation, and Housing Tenure in the United States, 1997-2014. *Int J MCH AIDS*. 2021;10(1):7-18.

37. Donnelly R, Farina MP. How do state policies shape experiences of household income shocks and mental health during the COVID-19 pandemic? *Soc Sci Med*. 2021;269:113557.

38. Singh GK, Girmay M, Allender M, Ramey CT. Digital divide: marked disparities in computer and broadband internet use and associated health inequalities in the United States. *International Journal of Translational Medical Research and Public Health*. 2020;4(1):64-79.