Prevalence and Correlates of SARS CoV-2 Among a Community-Based Sample Recruited Using Randomized Venue-Based Sampling. Essex County, NJ, 2020

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Abstract

Disparities in morbidity and mortality related to COVID-19 based on race and ethnicity have been documented in the USA. However, it is unclear if these disparities also exist at the exposure stage. To determine this, studies are needed to document the underlying burden of disease, potential disparities through serologic surveillance. Additionally, such studies can help identify where along the disease spectrum (e.g., exposure, infection, diagnosis, treatment, death) and with regard to the structural factors that necessitate public health and/or clinical interventions. Our objectives in this study were to estimate the true burden of SARS CoV-2 in the community of Essex County, NJ, an early and hard hit area, to determine the correlates of SARS CoV-2 prevalence and to determine if COVID-19 disparities seen by race/ethnicity were also reflected in SARS CoV-2 burden. We utilized venue-based-sampling (VBS) to sample members of the community in Essex County. Participants completed a short electronic survey and provided finger stick blood samples for testing. We sampled 924 residents of Essex County, New Jersey. Testing conducted in this study identified 83 (9.0%) participants as positive for SARS-CoV-2 antibodies. Importantly, our findings suggest that the true burden of SARS-Cov-2 and the pool of persons potentially spreading the virus are slightly more than six times than that suggested by PCR testing Notably, there were no significant differences in odds of testing positive for SARS CoV-2 antibodies in terms of race/ethnicity where we compared Black and Latinx participants to other race participants. Our study suggests that disparities in COVID-19 outcomes stem from potential upstream issues such as underlying conditions, access to testing, and access to care rather than disparities in exposure to the virus.

Keywords SARS CoV-2 · Seroprevalence · Correlates · Disparities

Introduction

Disparities in the USA based on race and ethnicity with regard to COVID-19 have been documented in terms of morbidity and mortality, but it is unclear if there are similar disparities in exposure to SARS CoV-2 [1–7]. While such patterns parallel other health conditions, the underlying psychosocial and structural mechanisms that enable these disparities continue to be elucidated, minority stressors and social inequities are surely the drivers of the disease as noted in recent conceptualizations of COVID-19 and other diseases [8–10].

To this end, studies are needed to document the underlying burden of disease through serologic surveillance. These types of studies are an important complement to case reporting and data on morbidity and mortality. Additionally, seroprevalence studies empower public health practitioners and others to document potential disparities in the true burden and to identify where along the disease spectrum (e.g., exposure, infection, diagnosis, treatment, death) and with regard to the structural factors that necessitate public health and/or clinical interventions.

For example, if the disparities exist at the exposure stage, interventions might be needed to mitigate the conditions

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which facilitate exposure. In contrast, if the disparities are only seen in outcomes that are exacerbated by underlying medical conditions or access to care, further upstream health interventions may be needed. Such initiatives are critically important since some 30% infected persons are asymptomatic; thus, our understanding of the burden of disease is informed solely by case reporting and may not capture the actual profile of the diseases particularly in hard to reach and marginalized populations [11].

SARS CoV-2 initially manifested in the locally in the Northeastern region of the USA where morbidity and mortality were extremely high in the second quarter of 2020. Essex County, New Jersey, adjacent to New York City, a COVID-19 epicenter, ranks third in New Jersey as of mid-March 2021 for COVID-19 cases (69,386) and deaths (2,431) translating to a morbidity and mortality rate of approximately 8700 per 100,000 and 305 per 100,000 respectively [12, 13]. By comparison, the rate of the cases is comparable in the USA, although morbidity is lower at the rate of 164 per 100,000 [14]. The extent to which these differences in morbidity are due to temporal factors (i.e., when the pandemic emerged), structural factors or the interaction of both has yet to be delineated.

Essex County is highly diverse along numerous strata with a majority of residents who are Black or Latino (62.7%), a high proportion living in poverty (15.8%), and a densely populated region with 6000 residents per square mile [13]. It is well documented that communities of color, those living in poverty, and in dense residential settings experience disparities in disease burden, morbidity, and mortality, for instance, HIV, diabetes, maternal coronary heart disease, all-cause mortality, breast cancer and hepatocellular carcinoma, alcohol/substance use, and of course COVID-19 to name just a few [7, 15–21].

Our objectives in this study were to estimate the true burden of SARS CoV-2 in the community, to determine the correlates of SARS CoV-2 prevalence and to determine if COVID-19 disparities seen by race/ethnicity were also reflected in SARS CoV-2 burden.

Methods

We utilized venue-based-sampling (VBS) to sample members of the community in Essex County. VBS is often employed as an alternative sampling method where simple random sampling is not feasible. In VBS, the venues are randomized as a proxy for randomizing the attendees of the venues. For example, VBS is the standard to sample certain populations at high risk for HIV infection where the population is known to attend identifiable venues. VBS is also the standard sampling method used by CDC for men who have sex with men in the USA in National

HIV Behavioral Surveillance (NHBS) and is used for other populations internationally but to our knowledge has not been used for SARS CoV-2 [22, 23]. North Jersey Community Research Initiative (NJCRI), which has over 20 years' experience in VBS as the implementing partner in NHBS for New Jersey, performed the VBS sampling for the present study by utilizing their mobile units, which have medical equipment, survey and phlebotomy space, and a private exam room. These units were also outfitted for COVID-19 by adding additional air filtration units and plexi-glass dividers to keep participants and staff safe. We identified venues using Google.com searches using the key words "Supermarkets in Essex County" and "Groceries in Essex County" to search for all potential locations. We identified 205 potential locations. Days and hours of operation were verified by contacting each venue directly. Venues, days, and times of operation were entered in an Excel spreadsheet. To map the venues, we used R 4.0.2 GUI (The R Foundation for Statistical Computing, Austria) to manipulate and analyze the data. Specifically, we used "tidygeocoder" package 1.0.1 to extract coordinates of each store from US Census and OpenStreetMap (OSM) dataset. For each month of sampling, approximately 42 venue-day-times were randomly sampled and scheduled for a sampling event. NJCRI's mobile units and staff used the VBS schedule and travelled to these grocery store sites. At the site, potential participants were systematically approached for a standard two-hour period of time, asked to stop for screening (intercept), screened for eligibility, and, if eligible, invited to participate and provide verbal informed consent. Participants who agreed to participate completed a short computer-based survey administered by study staff, using a tablet computer.

The survey included questions on basic self-reported demographics, COVID-19 symptoms (including: fever, dry cough, shortness of breath, chills, headache, sore throat, muscle pain/ aches, new loss of taste or smell, GI issues, neurologic symptoms) since January 2020, seeking viral PCR testing, PCR results, and seeking antibody testing and antibody results. Participants were then asked to provide a blood sample collected by finger stick with the Neoteryx Mitra Collection device to use for SARS-CoV-2 antibody testing [24]. Dried sticks were preserved by the NJCRI collection team or at the testing laboratory at room temperature for up to a week, according to manufacturer's instructions. At the time of testing, dried blood from the Mitra device was eluted overnight at 4 °C, based on published protocols [24]. The eluate was diluted with 2% non-fat dry milk to1:80 and utilized for detection of IgG antibodies to recombinant receptor binding domain (RBD) of the SARS-CoV-2 Spike (100 ng/well), utilizing standard enzyme-linked immunosorbent assay (ELISA) protocols [25, 26]. To interpret the ELISA data, we calculated a cut off of $OD_{405} = 0.3$ (mean + 3

standard deviations) by testing finger-stick eluates from 50 COVID-19 PCR-negative subjects.

Participants were given a result-return card to enable them to call in to the study team for their antibody results a week after sample receipt by the laboratory. Participants received $25 in cash for their participation. This study had ethical approval from the Rutgers IRB. Survey data and lab data were merged in SAS (v9.4). Descriptive, bivariate, and multivariable analyses were conducted in SAS (v9.4).

Results

From September 15, 2020, to December 22, 2020, we conducted 92 randomly selected sampling events from geographically diverse locations in Essex County where we systematically approached patrons for screening. We approached 1349 individuals for screening. Of these, 928 (68.8%) stopped and agreed to be screened, 928 (100%) were eligible and agreed to participate, and 924 (99.6%) consented and had complete survey and laboratory data for analysis.

Our sample population was mostly over 39 years of age (n = 593, 64.2%) with a mean age of 44.7 years, mostly male at birth (n = 584, 63.2%), predominantly Black (n = 656, 71.0%), and Latino (n = 194, 21.0%). A majority had a high school diploma or some college education (n = 652, 70.5%). Only 343 (37.1%) were employed full or part-time, while 398 (43.1%) reported being unemployed. Personal annual income reported by participants was low, with almost half, 442 (47.8%), reporting a personal annual income of less than $15,000 while another 300 (32.5%) reported an income of between $15,000 and $35,000. Homelessness was common in our sample, with 251 (27.2%) reporting being homeless sometime in the 12 months preceding the survey and 181 (19.6%) reporting being homeless at the time of the study. A majority of the sample reported living in Newark (n = 704, 76.2%). Finally, 77.9% (n = 720) of the sample reported having some sort of health insurance at the time of the study (Table 1).

In terms of SARS CoV-2 risks, just over half of the sample reported living alone (11.5%) or with just one other person (40.4%) and only 14.5% reported living in households with five or more persons. Only a small proportion of the sample (5.0%) reported having had someone in their household diagnosed with COVID-19. The majority of the sample reported leaving their house daily (84.2%), and only 4.8% reported only leaving home once a month or less than once a month. Only a few participants reported a previous positive PCR test result (13/924, 1.4%).

Only 6.5% of the sample reported any COVID-19 like symptoms since January 2020, while 45.9% reported having sought out a COVID-19 test. In total, 13 (1.4%)

Table 1 Demographics, symptoms, testing seeking, and risk indicators and prevalence of SARS-CoV-2 antibody prevalence in a community sample, Essex County, NJ, 2020

Variable	N (924)	% (100)
Age		
18–21	63	6.8
22–29	111	12.0
30–39	157	17.0
40–49	185	20.0
50+	408	44.2
Sex at birth		
Female	340	36.8
Male	584	63.2
Race/ethnicity		
Native American	2	0.2
Asian	6	0.6
Black	656	71.0
White	44	4.8
Latino	194	21.0
Other	11	1.2
Mixed	6	0.6
Missing	5	0.5
Educational attainment		
None	2	0.2
Grades 1–8	29	3.1
Grade 9–11	170	18.4
HS diploma/GED	466	50.4
Some college	186	20.1
Bachelors	53	6.4
Any grad school	12	1.3
Employment status		
Full time	248	26.8
Part time	95	10.3
Homemaker	11	1.02
Student	9	1.0
Retired	42	4.6
Disabled	120	13.0
Unemployed	398	43.1
Missing	1	0.1
Personal annual income		
≤14,999	442	47.8
15,000–35,000	300	32.5
36,000–50,000	72	7.8
51,001–80,000	34	3.7
>80,000	76	8.2
Homeless 12 months prior to survey	251	27.2
Homeless at time of survey	181	19.6
Residential locality within Essex County		
Belleville	1	0.1
Bloomfield	15	1.6
East Orange	56	6.1
Elizabeth	19	2.1

Table 1 (continued)

Variable	N (924)	% (100)
Hillside	2	0.2
Irvington	59	6.4
Maplewood	2	0.2
Montclair	3	0.3
Newark	704	76.2
Orange	52	5.6
Roselle	1	0.1
Short Hills	1	0.1
Verona	2	0.2
West Orange	6	0.7
Homeless	1	0.1
Has health insurance	720	77.9
Any COVID-19 symptoms	60	6.5
Sought a polymerase chain reaction (PCR) virus test	424	45.9
Got PCR test	407	44.1
Got PCR result	383	41.5
Reported a positive previous PCR test		
Yes	13	1.4
No	911	98.6
Sought Antibody (AB) test	33	3.6
Got Ab test outside study	29	3.1
Got Ab result outside study	23	2.5
Reported a previous positive AB test		
Yes	5	0.5
No	919	95.5
SARS CoV-2 Antibody result		
Negative	841	91.0
Positive	83	9.0
Household size (including respondent)		
1	106	11.5
2	373	40.4
3	193	20.9
4	118	12.8
5+	134	14.5
Any household COVID-19 diagnosis		
Yes	46	5.0
No	878	95.0
How often respondent leaves the house each week		
Everyday	778	84.2
Weekly	111	12.0
Once a month	21	2.3
Less than once a month	14	1.5

participants reported receiving a positive SARS-CoV-2 PCR test result. While 33 participants (2.6%) sought a SARS-CoV-2 antibody test outside of the study, only 0.5% of the sample reported a positive antibody result. Testing

conducted in this study identified 83 (9.0%) participants as positive for SARS-CoV-2 antibodies (Fig. 1).

In our bivariate analysis, only age ($X^2 = 16.1$, $p < 0.01$), employment status (X^2 4.8, $p = 0.03$), household diagnosis of COVID-19 ($p = 0.01$), and reporting a previous positive PCR test ($p < 0.01$) were significantly associated with testing positive for SARS CoV-2 antibodies. Antibody prevalence across age groups was not uniform nor was prevalence higher in older participants. Indeed, 18–21-year olds had the highest prevalence at 19.1%. Interestingly, reporting homelessness in the 12 months preceding the survey was significantly negatively correlated with testing positive for SARS CoV-2 antibodies ($X^2 = 4.9$, $p = 0.03$) (Table 2).

In our multivariable analysis, we included age, race/ethnicity, sex assigned at birth, employment status, personal annual income, previous PCR test, household COVID-19 diagnosis, and homelessness in the 12 months prior to the study. While controlling for all of these variables simultaneously only age and household COVID-19 diagnosis were significantly associated with higher odds of testing positive for SARS CoV-2 antibodies. In terms of age, younger persons (18–21) had significantly higher odds (adjusted odds ratio [AOR] 5.6, 95% confidence interval [95% CI] 1.8, 17.2, $p < 0.01$) of testing positive for SARS CoV-2 antibodies compared to those aged 22–29. Those who previously had a positive PCR test had higher odds (AOR 11.3, 95% CI 3.2, 38.9, $p < 0.01$) of testing positive for SARS CoV-2 antibodies. Notably, there were no significant differences in odds of testing positive for SARS CoV-2 antibodies in terms of race/ethnicity where we compared Black and Latinx participants to other race participants.

Discussion

We successfully sampled a large number of residents of Essex County, New Jersey, for serological testing for SARS CoV-2 antibodies. Our sample was predominantly Black and Latino and residing in Newark. Importantly, our findings suggest that the true burden of SARS-Cov-2 and the pool of persons potentially spreading the virus are slightly more than six times than that suggested by PCR testing. This burden from our robustly sampled community-based study is higher than most estimates obtained through studies of remnant blood samples from hospitals (4.2% antibody prevalence), samples from staff at a public-school system (2.9% antibody prevalence), and residents of a California county recruited with targeted Facebook ads (1.5% antibody prevalence). These differences underscore the importance of conducting robust community-based sampling to determine the true burden of disease [27–29]. Moreover, with only 6.5% of the sample reporting any COVID-19-like symptoms, our finding suggests that the number of asymptomatic persons may be
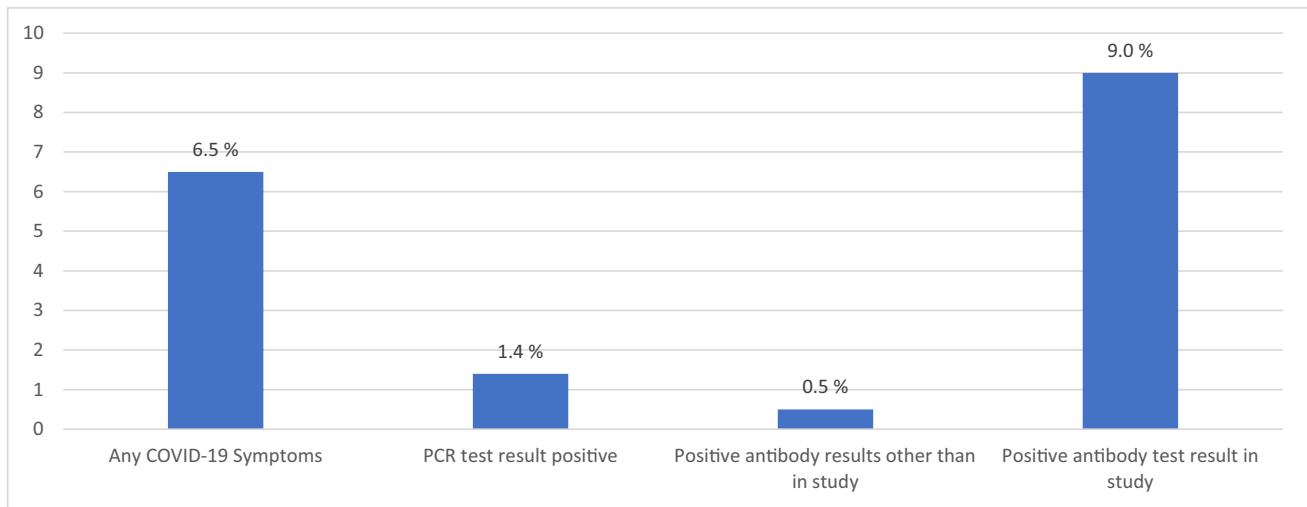
Fig. 1 COVID-19 and SARS-CoV-2 indicators among a community sample, Essex County, NJ, 2020

close to 1.5 times greater than anyone reporting symptoms (it is noted however that the symptoms listed might include other conditions).

In our bivariate analysis, we found that antibody prevalence was higher among younger and older persons, among those who were employed, those that were homeless sometime in the 12 months preceding the survey, and those who reported someone in their household being diagnosed with COVID-19. We did not find significant differences in SARS CoV-2 antibody prevalence by race/ethnicity, or frequency of leaving home. Other studies have also noted ongoing employment as potential risk factor serving as proxy for the risks experienced by front line workers. Indeed, our multivariable analysis suggests that only younger age and having previously received a positive PCR test for the virus were associated with SARS CoV-2 antibodies (Table 3).

Our study has limitations. VBS may not reach individuals who do not do their own shopping or live in settings where food is provided, thus introducing some form of sampling bias. Secondly, while Essex County is predominantly populated by Black/Latino individuals, our study oversampled these groups. This may be due to lower enthusiasm for participation among other race/ethnicity groups that may not be as altruistic or interested in the incentive provided by the study. Despite these limitations, we were able to sample a large number of individuals and estimate SARS-CoV-2 antibody prevalence in a county highly impacted by the current pandemic. Our findings underscore the importance of conducting seroprevalence studies in addition to case reporting to understand the true magnitude of SARS-CoV-2 impact on communities and plan for mitigation strategies to reduce transmission.

In conclusion, our study suggests that disparities in COVID-19 outcomes stem from potential upstream issues such as underlying conditions, access to testing, and access to care rather than disparities in exposure to the virus. In effect, these patterns manifest a biopsychosocial understanding of COVID-19, namely, the structural and social inequities that undermine health and interfere with access to effective healthcare by communities of color and other marginalized populations [9]. Our findings also suggest that other factors may be influencing these disparities. These factors may include hesitancy to get tested or hesitancy to seek care due to concerns about health care coverage/costs of care and/or fear and mistrust of the medical profession [8]. This bears further investigation particularly in relation to whether persons of color present for COIVD-19 care at more advance stages of the disease than other populations. SARS CoV-2 has exposed, in a dramatic way, the underlying systemic issues that influence health disparities in regard to race and ethnicity in the USA and point to ongoing vigilance in creating conditions that foster health equity both locally and internationally [8].

Table 2 Bivariate associations with SARS CoV-2 prevalence among a community sample, Essex County NJ, 2020

Variable	SARS CoV-2 negative (841)		SARS CoV-2 positive (83)		X^2	p
	n	%	n	%		
Age					16.1	<0.01
18–21	51	81.0	12	19.1		
22–29	106	96.0	5	4.5		
30–39	137	87.3	20	12.7		
40–49	175	94.6	10	5.4		
50+	372	91.2	36	12.1		
Sex at birth					1.1	0.3
Female	305	89.7	35	10.3		
Male	536	91.8	48	8.2		
Race/ethnicity						1.0*
Black	596	90.9	60	9.2		
Latinx	177	91.2	17	8.8		
Other	68	91.9	6	8.1		
Educational attainment					3.4	0.2
Less than high school	189	94.0	12	6.0		
High school	423	90.8	43	9.2		
More than high school	229	89.1	28	10.9		
Employment status					4.8	0.03
Employed	303	88.3	40	11.7		
Not working	538	92.6	43	7.4		
Personal annual income					0.6	0.4
<35,000	678	91.4	64	8.6		
≥35,000	163	89.6	19	10.4		
Homeless in the 12 months prior to survey					4.9	0.03
Yes	237	94.4	14	10.4		
No	604	89.6	69	8.6		
Homeless at time of survey					2.3	0.1
Yes	170	93.9	11	6.1		
No	671	90.3	72	9.7		
Residential locality within Essex County					0.4	0.8
Newark	640	90.9	64	9.1		
Other	201	91.4	19	8.6		
Household size (including respondent)					7.3	0.1
1	101	95.3	5	4.7		
2	945	92.5	28	7.5		
3	172	89.1	21	10.9		
4	102	86.4	16	13.6		
5+	121	90.3	13	9.7		
Any household COVID-19 diagnosis						0.01*
Yes	37	80.4	9	19.6		
No	304	91.6	74	8.4		
How often respondent leaves the house each week					0.4	0.5
Everyday	706	90.8	72	9.3		
Less than everyday	135	92.5	11	7.5		
Reported a positive previous PCR test						<0.01*
Yes	7	53.9	6	46.2		
No	834	91.6	77	8.5		

*Fisher exact test

Table 3 Adjusted multivariable associations with SARS CoV-2 antibody prevalence among a community sample, Essex County NJ, 2020

Variable	AOR	95% CI	p
Age			
18–21	5.6	1.8, 17.2	<0.01
22–29	Ref	-	-
30–39	3.7	1.3, 10.5	0.1
40–49	1.4	0.14, 4.3	0.6
50+	2.5	0.9, 6.8	0.07
Race/ethnicity			
Black	1.2	0.5, 3.3	0.7
Latinx	1.1	0.4, 3.1	0.9
Other	Ref	-	-
Birth sex			
Female	1.2	0.7, 1.9	0.5
Male	Ref	-	-
Employment			
Employed	1.4	0.8, 2.3	0.2
Not working	Ref	-	-
Personal annual income			
<35,000	1.1	0.6, 1.9	0.8
≥35,000	Ref	-	-
Reported a positive previous PCR test			
Yes	11.3	3.2, 38.9	<0.01
No	Ref	-	-
Any household COVID-19 diagnosis			
Yes	2.1	0.9, 4.9	0.08
No	Ref	-	-
Homeless in 12 months prior to the study			
Yes	Ref	0.9, 3.2	0.1
No	1.7	-	-

Data Availability By request to the first author.

Code Availability Not applicable.

Declarations

Disclaimer Neither funder had a role in the design, implementation, or analysis of this study.

Ethics Approval Ethics approval was given by the Rutgers University IRB.

Consent to Participate All participants provided verbal informed consent.

Conflict of Interest The authors declare no competing interests.

References

1. Zelner J, Trangucci R, Naraharisetti R, Cao A, Malosh R, Broen K, et al. Racial disparities in coronavirus disease 2019 (COVID-19) mortality are driven by unequal infection risks. Clin Infect Dis. 2021;72(5):e88–95.
2. Aleligne YK, Appiah D, Ebong IA. Racial disparities in coronavirus disease 2019 (covid-19) outcomes. Curr Opin Cardiol. 2021. https://doi.org/10.1097/HCO.0000000000000847.
3. Anderson-Carpenter KD, Neal ZP. Racial disparities in COVID-19 impacts in Michigan, USA. J Racial Ethn Health Disparities. 2021.
4. Pierce JB, Harrington K, McCabe ME, Petito LC, Kershaw KN, Pool LR, et al. Racial/ethnic minority and neighborhood disadvantage leads to disproportionate mortality burden and years of potential life lost due to COVID-19 in Chicago, Illinois. Health Place. 2021;68:102540.
5. Dai CL, Kornilov SA, Roper RT, Cohen-Cline H, Jade K, Smith B, et al. Characteristics and factors associated with COVID-19 infection, hospitalization, and mortality across race and ethnicity. Clin Infect Dis. 2021.
6. Tai DBG, Shah A, Doubeni CA, Sia IG, Wieland ML. The disproportionate impact of COVID-19 on racial and ethnic minorities in the United States. Clin Infect Dis. 2021;72(4):703–6.
7. Weiser JK, Tie Y, Beer L, Neblett Fanfair R, Shouse RL. Racial/ethnic and income disparities in the prevalence of comorbidities that are associated with risk for severe COVID-19 among adults receiving HIV care, United States, 2014–2019. J Acquir Immune Defic Syndr. 2021;86(3):297–304.
8. Halkitis PN. A new public health psychology to mend the chasm between public health and clinical care. Am Psychol. 2020;75(9):1289–96.
9. Halkitis PN. Managing the COVID-19 pandemic: biopsychosocial lessons gleaned from the AIDS epidemic. J Public Health Manag Pract. 2021;27 Suppl 1, COVID-19 and public health: looking back, moving forward:S39-S42.
10. Shiau S, Krause KD, Valera P, Swaminathan S, Halkitis PN. The burden of COVID-19 in people living with HIV: a syndemic perspective. AIDS Behav. 2020;24(8):2244–9.
11. Oran DP, Topol EJ. The proportion of SARS-CoV-2 infections that are asymptomatic: a systematic review. Ann Intern Med. 2021.
12. Department of Health NJ. New Jersey COVID-19 Information Hub 2021 [Available from: https://covid19.nj.gov/forms/datadashboard. Accessed 28 Sept 2021.
13. Census US. American Fact Finder 2018 [Available from: https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml. Accessed 28 Sept 2021.
14. WHO. WHO Emergency Dashboard: WHO; 2021 [Available from: https://covid19.nj.gov/index.html#live-updates. Accessed 28 Sept 2021.
15. Arayasirikul S, Pomart WA, Raymond HF, Wilson EC. Unevenness in health at the intersection of gender and sexuality: sexual minority disparities in alcohol and drug use among transwomen in the San Francisco Bay Area. J Homosex. 2018;65(1):66–79.
16. Beer L, Bradley H, Mattson CL, Johnson CH, Hoots B, Shouse RL, et al. Trends in racial and ethnic disparities in antiretroviral therapy prescription and viral suppression in the United States, 2009–2013. J Acquir Immune Defic Syndr. 2016;73(4):446–53.
17. Beer L, Oster AM, Mattson CL, Skarbinski J, Project MM. Disparities in HIV transmission risk among HIV-infected black and white men who have sex with men, United States, 2009. AIDS. 2014;28(1):105–14.
18. Reback CJ, Clark K, Holloway IW, Fletcher JB. Health disparities, risk behaviors and healthcare utilization among transgender

women in Los Angeles County: a comparison from 1998–1999 to 2015–2016. AIDS Behav. 2018;22(8):2524–33.

19. Watt GP, John EM, Bandera EV, Malone KE, Lynch CF, Palmer JR, et al. Race, ethnicity and risk of second primary contralateral breast cancer in the United States. Int J Cancer. 2021.

20. Malek AM, Wilson DA, Turan TN, Mateus J, Lackland DT, Hunt KJ. Maternal coronary heart disease, stroke, and mortality within 1, 3, and 5 years of delivery among women with hypertensive disorders of pregnancy and pre-pregnancy hypertension. J Am Heart Assoc. 2021;10(5):e018155.

21. Wong RJ, Saab S, Konyn P, Sundaram V, Khalili M. Rural-urban geographical disparities in hepatocellular carcinoma incidence among US adults, 2004–2017. Am J Gastroenterol. 2021;116(2):401–6.

22. Wang J, Li D, Wiltse A, Emo J, Hilchey SP, Zand MS. Application of volumetric absorptive microsampling (VAMS) to measure multidimensional anti-influenza IgG antibodies by the mPlex-Flu assay. J Clin Transl Sci. 2019;3(6):332–43.

23. Davidow A, Kanaujia GV, Shi L, Kaviar J, Guo X, Sung N, et al. Antibody profiles characteristic of Mycobacterium tuberculosis infection state. Infect Immun. 2005;73(10):6846–51.

24. Gennaro ML, Affouf M, Kanaujia GV, Brusasca PN, Mangura B, Reichman L. Antibody markers of incident tuberculosis among HIV-infected adults in the USA: a historical prospective study. Int J Tuberc Lung Dis. 2007;11(6):624–31.

25. Routledge I, Epstein A, Takahashi S, Hakim J, Janson O, Duarte E, et al. Citywide serosurveillance of the initial SARS-CoV-2 outbreak in San Francisco. Res Sq. 2021.

26. Lopez L, Nguyen T, Weber G, Kleimola K, Bereda M, Liu Y, et al. Seroprevalence of anti-SARS-CoV-2 IgG antibodies in the staff of a public school system in the Midwestern United States. medRxiv. 2020.

27. Bendavid E, Mulaney B, Sood N, Shah S, Ling E, Bromley-Dulfano R, et al. COVID-19 Antibody seroprevalence in Santa Clara County, California. 2020:2020.04.14.20062463.

28. Martino RJ, Krause KD, Griffin M, LoSchiavo CE, Comer-Carruthers C, Karr A, et al. A national survey of COVID-19 testing in the US. LGBTQ Populations. Public Health Rep. 2021;IN PRESS.

29. Weaver KE, Rowland JH, Bellizzi KM, Aziz NM. Forgoing medical care because of cost: assessing disparities in healthcare access among cancer survivors living in the United States. Cancer. 2010;116(14):3493–504.