SARS-CoV-2 Infection Among People Living With HIV Compared With People Without HIV: Survey Results From the MACS-WIHS Combined Cohort Study

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Background: Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection and coronavirus disease 2019 (COVID-19) symptoms among people living with HIV (PLWH) are not well described.

Setting: Longitudinal survey within the MACS/WIHS Combined Cohort Study (MWCCS) of PLWH compared with similar HIV-seronegative (SN) individuals.

Methods: Telephone-administered survey of MWCCS participants at 13 clinical research sites across the United States addressing COVID-19 symptoms, SARS-CoV-2 testing, and pandemic impact on social distancing and antiretroviral therapy (ART) use. Primary data collection occurred during May (wave 1), June–July (wave 2), and August–September, 2020 (wave 3).

Results: One-third of MWCCS participants were tested for SARS-CoV-2 infection; 10% was tested ≥2 times. Similar proportions of PLWH and SN participants were tested, but SARS-CoV-2 positivity was higher among PLWH than among SN individuals (9.4% vs 4.8%, $P = 0.003$). Odds of SARS-CoV-2 positivity remained higher among PLWH after adjusting for age, sex, race/ethnicity, and study

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site (adjusted odds ratio = 2.0, 95% confidence interval = 1.2 to 3.2). SARS-CoV-2 positivity was not associated with CD4 cell counts among PLWH. Among SARS-CoV-2 positive participants, 9% had no symptoms, 7% had 1–2 mild symptoms, and 84% had ≥3 symptoms. Most of the (98%) participants reported physical distancing during all survey waves; self-reported ART adherence among PLWH was not adversely affected during the pandemic compared with the previous year (similar adherence in 89% of participants, improved in 9% of participants, and decreased in 2% of participants).

Conclusions: Despite similar SARS-CoV-2 testing and physical distancing profiles by HIV serostatus among MWCCS participants, PLWH who reported SARS-CoV-2 testing were more likely to have a positive test result. Additional studies are needed to determine whether and why PLWH are at increased risk of SARS-CoV-2 infection.

Key Words: coronavirus, testing, symptoms, PLWH, CD4, distancing, MWCCS

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INTRODUCTION

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus responsible for coronavirus disease 2019 (COVID-19), manifests itself with a variety of clinical symptoms during infection. Although most people who become infected are either asymptomatic or experience mild symptoms, the illness can be severe and/or life-threatening.[1] Between March and September 2020, with infection levels surging across the United States,[2] more than 7 million people tested positive for SARS-CoV-2 and 200,000 people died.[3,4] In an effort to mitigate the impact of the pandemic, many states mandated policies of social distancing and closures of businesses and other venues.[5]

COVID-19 severity increases among adults with each decade of advancing age[6] and among those with certain underlying health conditions and comorbidities. It is unclear whether SARS-CoV-2 infection is higher among people living with HIV (PLWH); however, some recent studies suggest that PLWH may have increased disease severity and risk of hospitalization.[7] A recent review of SARS-CoV-2 cases among PLWH indicated that although documented combined HIV and SARS-CoV-2 coinfection was uncommon globally, greater HIV-related immunosuppression predisposed PLWH to more severe COVID-19 disease.[8,9] Analysis of 192 PLWH suggested that a CD4 count <200 cells/μL (vs ≥200 cells/μL) was associated with a 4.9-fold higher odds of progression to severe COVID-19.[8] Currently, recommendations for prevention of SARS-CoV-2 infection and COVID-19 management among PLWH are no different than those for the general population. The US Centers for Disease Control and Prevention (CDC) recommend that "until more is known, additional caution for all PLWH, especially those with advanced or poorly controlled HIV, is warranted" and that PLWH should follow CDC prevention recommendations.[10] However, PLWH are more likely than the general population to have risk factors associated with greater SARS-CoV-2 exposure and/or worse COVID-19 outcomes, including higher prevalence of adverse social determinants of health (eg, unstable housing and public transportation use) and comorbidities (eg, cardiovascular disease, obesity, and smoking).[11] PLWH in the United States are also disproportionately represented among racial minorities and groups hit hardest by the SARS-CoV-2 pandemic.

We previously reported similar prevalences and types of COVID-19 symptoms among PLWH and similar HIV-seronegative (SN) adults in the MACS/WIHS Combined Cohort Study (MWCCS) during Spring 2020.[12(p1)] In this analysis, we characterize the evolving pandemic among MWCCS participants by extending our initial report to include additional waves of data collection through September 2020, after the surge of COVID-19 that occurred in the United States in the Spring and Summer of 2020.

METHODS

The MWCCS integrates 2 long-standing, prospective, multicenter US cohorts of PLWH and SN people, the Multicenter AIDS Cohort Study (MACS) and the Women's Interagency HIV Study (WIHS). Clinical research sites are located in New York City (Brooklyn, Bronx), Mid-Atlantic (Baltimore, MD; Washington DC), Southeast (Chapel Hill, NC; Atlanta, GA; Miami, FL), South (Birmingham, AL; Jackson MS), Midwest (Chicago, IL; Columbus. OH; Pittsburgh, PA), and California (San Francisco, Los Angeles). Characteristics of participants are described in detail elsewhere.[13] The MACS targeted enrollment of men who have sex with men (MSM) with some censoring of seronegative participants in 1995 to achieve an approximate1:1 target ratio of PLWH to seronegative men for follow-up, and the WIHS enrollment targeted women living with HIV and similar seronegative women at a 3:1 ratio.

Three waves of an interviewer-administered telephone survey were conducted between April 8, 2020, and September 30, 2020, with most of the surveys occurring in May (wave 1), June and July (wave 2), and August and September (wave 3). A subset of MWCCS sites conducted an optional fourth administration of the survey involving 70 participants in September 2020. These data were combined with wave 3 data for these analyses to report ever positive among those tested multiple times. Among those reporting symptoms, the severest symptoms reported across waves were reported. The survey was offered in English and Spanish. All MWCCS participants were eligible. Verbal consent was obtained before the telephone interview that was conducted by trained study staff. Participants were financially compensated for their time. The COVID-19 survey was reviewed and approved by each MACS and WIHS clinical research site's local Institutional Review Board.

The COVID-19 survey was developed by MWCCS investigators to capture self-reported information regarding COVID-19 symptoms, SARS-CoV-2 testing, preventive measures, and psychosocial effects of the pandemic (the latter are not included in this report). The survey was minimally revised after the first wave. Both versions of the survey are in the public domain and available at https://statepi.jhsph.edu/mwccs/data-collection-forms/ (V100

COVID forms). Interviewers asked participants questions regarding COVID-19 symptoms, SARS-CoV-2 testing, antiretroviral therapy (ART) adherence, and adoption of social distancing measures. Questions addressing COVID-19 symptom severity (mild, moderate, or severe for each self-reported symptom) and cohabitation with someone who tested positive for SARS-CoV-2 were added after the first wave of the survey.[12]

This analysis includes 3 waves of COVID-19 symptoms and self-reported SARS-CoV-2 testing data. SARS-CoV-2 testing included any self-reported viral diagnostic test through nasopharyngeal, nasal, or pharyngeal swabs or saliva (serum antibody tests were excluded from this analysis). Information regarding the type of SARS-CoV-2 testing was not collected in wave 1 (when antibody testing was not available, all tests in that wave were assumed to be for diagnosis of active infection). Type of test was collected during subsequent waves of survey administration when SARS-CoV-2 antibody, antigen, and nucleic amplification tests became more widespread. SARS-CoV-2 positivity was defined as a self-reported positive viral diagnostic test. We attempted to confirm all self-reported SARS-CoV-2 testing results (positive and negative) with medical record review. Of 95 people with self-reported SARS-CoV-2 positive test results, 54 (57%) results were confirmed by medical record abstraction, 41 (43%) results were pending (did not have any record available or were still awaiting requested records at time of analysis), and none (0%) were ascertained to be negative after record review. There were 30 people (12 PLWH; 18 SN individuals) who self-reported having been tested for SARS-CoV-2 but had unknown (pending) results at the time of analysis and were excluded from analysis.

Among PLWH, plasma CD4 and HIV RNA (viral load) and self-reported ART adherence data from the most recent in-person MACS or WIHS study visit, a median of 11.9 months [interquartile range (IQR) = 9.7–51.0] before the survey, were used.

Statistical Methods

Baseline MWCCS participant characteristics were obtained from the last in-person MACS and WIHS visit (2018–2019), stratified by HIV serostatus and sex. SARS-CoV-2 test positivity was explored overall by HIV serostatus, CD4 count ($\geq$500 vs $<$500 cells/μL and $<$350 vs 350–499 cells/μL), calendar month of testing, and sex.

COVID-19 symptom prevalence and severity were explored among participants reporting SARS-CoV-2 positive infection status. Among PLWH, ART adherence was compared among persons reporting SARS-CoV-2 positive testing vs those reporting SARS-CoV-2 negative testing vs those with no report of being tested. ART adherence reported during the pandemic was also compared with ART adherence reported the previous year (last WIHS/MACS visit). Social distancing measures self-reported at the time of the surveys were described. Differences among categorical variables were tested using the χ^2 analyses (or the Fisher exact test when values in subgroups were $<$5). Significance was evaluated using 2-tailed tests, at $P < 0.05$. We decided a priori to adjust analyses for age, sex, race, and study site given previous published literature establishing these as potentially associated with SARS-CoV-2 infection. SAS version 9.4 was used for all analyses.

RESULTS

Of 4330 MACS and WIHS participants, 3671 (85%) completed at least one survey, 500 (11%) could not be reached for the telephone interview, and 159 (4%) refused (see Table 1, Supplemental Digital Content, http://links.lww.com/QAI/B742). Among the 3671 participants who completed at least one survey, most of them (89%) completed 3 surveys. For each survey wave, the range of dates and number of participants included are further described in Table 1, Supplemental Digital Content, http://links.lww.com/QAI/B742.

Participants who completed $\geq$1 survey were 53% female individuals, 41% Black, 14% Hispanic, and 35% White (Table 1). Participants' median age was 58 years (IQR 50–65 years). Most of the PLWH reported taking ART (97%) and had an undetectable HIV viral load (73%) with a median CD4 cell count of 670 cells/μL (IQR 468–907 cells/μL) at their last study visit.

SARS-CoV-2 Testing

Characteristics of participants who reported having tested for SARS-CoV-2 infection were similar to those who did not (Table 1). Among those who reported testing, characteristics of PLWH and SN participants were similar (Table 1). More than one-third of MWCCS participants (N = 1234, 34%) were tested for SARS-CoV-2 infection at $\geq$1 time during the study period (April 1, 2020–September 31, 2020), including 391 (11%) participants who were tested $\geq$2 times. A similar proportion of PLWH and SN participants was tested for SARS-CoV-2 (34.3% vs 33.5%, respectively, Table 2).

Most SARS-CoV-2-tested participants reported undergoing nasopharyngeal swab (84%) or oropharyngeal swab (15%), with a lower proportion reporting saliva (0.8%) or "other type" (0.2%). The proportions of both PLWH (6.7%) and SN individuals (4.5%) who reported living with someone who tested positive for SARS-CoV-2 were $<$10% (Table 1); 100 participants reported living with someone who tested positive for SARS-CoV-2, and of them, 71% (71/100) reported getting tested and 41% (29/71) of those reported testing positive.

SARS-CoV-2 Positivity, HIV Serostatus, and CD4 Cell Count

The percentage SARS-CoV-2 positive among tested persons was higher in wave 1 (9.3%) than in wave 2 (4.4%) or wave 3 (4.5%), $P = 0.001$. Among 1248 MWCCS participants who were tested, SARS-CoV-2 positivity was higher among PLWH than SN individuals (9.4% vs 4.8%, $P = 0.003$) overall and at each visit wave: wave 1 (11.1% vs 6.7%, $P = 0.13$); wave 2 (5.4% vs 3.1%, $P = 0.21$); and wave 3 (6.1% vs 2.3%, $P = 0.02$). The proportion of positive tests

TABLE 1. Characteristics of MWCCS Participants Completing the MWCCS COVID-19 Survey, by SARS-CoV-2 Testing and HIV Serostatus

	No.	%	Column %						
			Tested for SARS-CoV-2			Not Tested for SARS-CoV-2			
	All	All	All Tested	PLWH	SN	All Not Tested	PLWH	SN	*P* Value Tested vs Not
Characteristics	**N = 3671**	**N = 3671**	**N = 1248**	**N = 769**	**N = 479**	**N = 2423**	**N = 1472**	**N = 951**	
Sex									0.95
Female	1938	53	53	59	42	53	62	39	
Male	1733	47	47	41	58	47	38	61	
Race and ethnicity									0.34
Black, non-Hispanic	1516	41	42	47	34	41	46	32	
Hispanic, any race	496	14	15	16	13	13	16	9	
White, non-Hispanic	1299	35	34	27	44	36	28	50	
Other, non-Hispanic	360	10	10	11	9	10	10	9	
Region of the United States									0.004
California	873	24	27	23	34	22	20	25	
Mid-Atlantic (Wash DC, MD)	648	18	17	18	16	18	16	21	
Midwest (IL, PA, OH)	932	25	23	23	22	27	24	31	
Northeast (NY)*	539	15	16	17	14	14	16	11	
South (AL, MS)*	186	5	5	6	3	5	7	3	
Southeast (NC, GA, FL)*	493	13	13	14	11	14	17	10	
Number of people who live with you‡									0.53
0	1241	36	37	37	37	36	37	34	
1–2	1896	56	54	54	55	56	55	58	
≥3	276	8	9	9	8	8	8	7	
Anyone you live with tested positive for coronavirus?	100	3	6	7	5	1	1	1	<0.0001
Currently use tobacco? (Smoke or vape)	829	24	23	25	21	25	27	22	0.42
Anyone you live with smoke tobacco?§	533	16	16	16	15	16	17	14	0.97
Age in years: median (IQR)	3671	58 (50–65)	57 (50–65)	56 (49–63)	60 (51–67)	58 (50–65)	56 (49–62)	61 (51–68)	0.46
Currently taking antiretroviral medications†	2176	97	NA	98	NA	NA	97	NA	0.16
Current CD4 cells/μL†: median (IQR)	2241	670 (468–907)	NA	677 (477–890)	NA	NA	667 (464–913)	NA	0.65
≥500	1602	71%		72%			71%		0.60
<500	639	29%		28%			29%		
Current HIV RNA copies/μL†: median (IQR)	2200	Und (und, 24)	NA	Und (und, 25)	NA	NA	Und (und, 24)	NA	0.71

*New York City, "Southeast" and the "South" study regions included only women participants. Note: men in this study were part of the former MACS cohort and women were part of the former WIHS cohort, now merged into the MACS/WIHS Combined Cohort Study (MWCSS).

†Current CD4 cell count, current HIV RNA, and antiretroviral medication history data are from participants' last in-person visit, median of 11.9 months before this survey was conducted.

‡Analysis was among 3413 people because there were 258 people missing data (ie, skipped or refused to answer) for number of people lived with.

§Analysis was among 3404 people because there were 267 people missing data (ie, skipped or refused to answer) on tobacco use in those they lived with; the χ^2 statistics was used for categorical variables and the Wilcoxon rank sum test was used for continuous variables, to test the variable differences between tested and not tested participants.

Und, undetectable HIV viral load (<20 copies/μL).

was also higher among PLWH, both men and women, than SN individuals: among 658 women tested (8.6% vs 5.9%, $P = 0.24$) and among 590 men tested (10.5% vs 4.0%, $P = 0.003$).

Among PLWH, the proportion of positive SARS-CoV-2 tests was similar among those with CD4 count <500 cells/μL vs those with CD4 count ≥500 cells/μL (9.8% vs 9.2%, $P = 0.79$; Fig. 1). The proportion of positive SARS-CoV-2 tests was not statistically different in PLWH with CD4 counts 350–499 vs <350 cells/μL (11.4% vs 8.3%, $P = 0.43$) or vs 92 participants with CD4 count <200 (7.5%, $P = 0.47$). Only 109 participants (43 men and 66 women) with CD4

TABLE 2. Cumulative Prevalence of SARS-CoV-2 Infection (April–September 2020), by HIV Serostatus Among MWCCS Participants

	Overall (Any Wave 1–3)					By Survey Wave*		
	Cum N	Cum Prev	PLWH	SN		1 (Spring 2020)	2 (Summer 2020)	3‡ (Fall 2020)
	N = 3671		N = 2241	N = 1430	*P*	N = 3415	N = 3387	N = 3325
SARS-CoV-2 diagnostic test†								
Tested ≥ 1 times	1248	34.0%	34.3%	33.5%	0.61	13.0%	15.6%	20.2%
Tested ≥ 2 times	391	10.7%	11.1%	10.0%	0.31	0%	4.3%	7.3%
SARS-CoV-2 diagnostic test result					0.003			
Positive§	95	7.6%	9.4%	4.8%		9.5%	4.6%	4.6%
Negative	1153	92.4%	90.6%	95.2%		90.5%	95.4%	95.4%

*Results in each wave for PLWH and SN participants were similar and, thus, were combined in the table above for the wave-specific result presentation. For those interested, the proportion of PLWH and SN participants tested ≥ 1 times was as follows: 13.5% vs 12.3% at wave 1; 16.1% vs 14.7% at wave 2; and 20.5% vs 19.7% at wave 3. The proportion of tested PLWH and SN participants who were positive for SARS-CoV-2 was as follows: 11.1% vs 6.7% at wave 1; 5.4% vs 3.1% at wave 2; and 6.1% vs 2.3% at wave 3.

†During most of the time this survey was conducted, SARS-CoV-2 antibody testing was not available outside of research settings. There were an additional 291 participants who reported having a blood test for SARS-CoV2; these antibody test results were not included in this analysis.

‡70 participants had wave 4 results, which are included here because their most recent results were reported.

§Participants who had multiple test results are included as positive if ever positive in the "overall" description of test results across all waves above.

cum, cumulative.

counts <350 cells/μL were tested for SARS-CoV-2, of whom 11.6% men and 6.1% women were SARS-CoV-2 positive (*P* for sex difference = 0.31). The proportion of positive SARS-CoV-2 tests was also similar by HIV viral load (among 21 PLWH with detectable vs 48 with undetectable: 2.8% vs 6.4%, *P* = 0.54).

As shown in Figure 2, across study sites, there was heterogeneity in the proportions of people with positive SARS-CoV-2 tests and differences in proportions of PLWH versus SN individuals who had positive tests (Fig. 2). The prevalence of SARS-CoV-2 positivity was higher among PLWH than SN participants in 8 of the 13 study sites (both California sites, all Midwestern sites, and the Brooklyn site), was modestly higher among PLWH than SN participants in 3 study sites (both Mid-Atlantic and Atlanta sites), and was lower in PLWH than SN participants at 2 sites (Bronx and the Mississippi/Alabama site, which each reported <100 people tested). After adjusting for age, sex, race, and study site, odds of SARS-CoV-2 test positivity among those tested remained higher among PLWH than SN participants (adjusted odds ratio = 2.0, 95% confidence interval = 1.2 to 3.2).

COVID-19 Symptoms

As summarized in Table 3, most of the (N = 80/95; 84%) SARS-CoV-2 positive participants reported >3 symptoms and more than one-third (35%) of SARS-CoV-2 positive participants reported >3 symptoms that were severe. Symptom severity was similar by HIV serostatus. Symptom severity increased with number of symptoms reported (Table 3). The most common symptoms reported as moderate or severe were myalgias (50%), headache (49%), loss of taste or smell (47%), cough (41%), chills (39%), shortness of breath (37%), and feeling feverish (33%); Table 3. However, no single symptom was reported by all SARS-CoV-2 positive participants, and many of the individual symptoms were reported as none or mild by most of the participants (Table 3).

Among PLWH who were SARS-CoV-2 positive, lower CD4 cell count was not associated with higher symptom severity. There was also no difference by CD4 cell count category (<350, 350–499, and ≥500 cells/μL) in the proportion of PLWH with ≥1 severe symptoms (56% vs 58% vs 51%, respectively, *P* = 0.89) and ≥3 severe symptoms (33% vs 42% vs 31%, respectively, *P* = 0.79).

Pandemic Impact

Self-reported social distancing practices were explored. Social distancing was consistently reported by 98% of participants across all surveys, whereas staying home "as much as possible" decreased modestly from 97% (Spring;

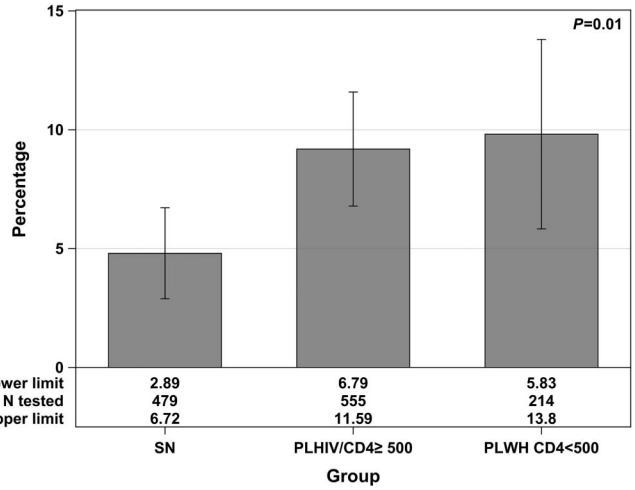

FIGURE 1. SARS-CoV-2 test positivity by HIV serostatus and most recent CD4 cell count, among persons tested for SARS-CoV-2.

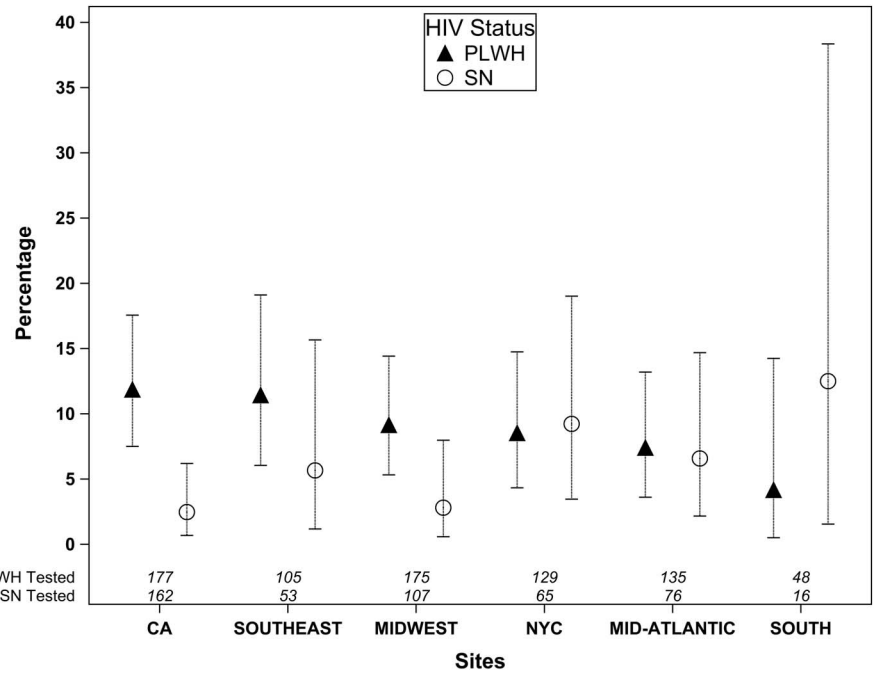

FIGURE 2. Percentage of positive SARS-CoV-2 tests among persons tested by study site region and HIV serostatus.

wave 1) to 93% (Fall; wave 3), $P < 0.001$. However, 13% of all participants in each wave reported not making any changes to their daily life and routine. In wave 1, 19% of PLWH and 13% of SN participants reported not making any changes. These findings did not change much over time, with 11%–17% of PLWH and 7%–14% of SN participants reporting not making changes in subsequent waves.

Participants reported not only social distancing but also staying at home all the time (self-isolating) because of "experiencing symptoms or having a positive test" (1%–3%), exposure to an infected person (1%–2%), or uncertainty about infection status (2%–5%, depending on wave). The prevalence of staying at home was similar by HIV serostatus (Fig. 1, Supplemental Digital Content, http://links.lww.com/QAI/B742). When our survey was first administered in April 2020, 10% of participants reported self-isolating; this proportion decreased over time and was 7% in May, 4% in June and July, and 3% in August and September (Fig. 1, Supplemental Digital Content, http://links.lww.com/QAI/B742).

We explored use of ART among PLWH during the pandemic (Table 2, Supplemental Digital Content, http://links.lww.com/QAI/B742). Most of the participants (95%) reported taking ART ≥95% of the time, with most of them reporting an excellent (53%) or very good (31%) job of taking ART "the way they were supposed to." Participants who reported being SARS-CoV-2 positive reported a lower prevalence of 100% ART adherence than those who tested negative (66% vs 76% $P = 0.02$) and more often missed a dose of ART on ≥1 days per month (52% vs 37%, $P = 0.02$). However, the prevalence of being off ART for ≥1 week was similar by SARS-CoV-2 test result status (10% vs 11%, $P = 0.088$, Table 2, Supplemental Digital Content, http://links.lww.com/QAI/B742). To further evaluate how pandemic-related disruptions may have changed ART adherence, we compared ART adherence reported in this MWCCS COVID survey with that reported when last measured as part of routine MACS and WIHS cohort data collection (approximately 1 year before the COVID survey). ART adherence reported in the COVID survey was similar to previously reported adherence in 89% of participants, improved in 9% of participants, and decreased in 2% of participants (none of whom were known to be SARS-CoV-2 positive) (Table 2, Supplemental Digital Content, http://links.lww.com/QAI/B742).

DISCUSSION

Despite similar SARS-CoV-2 testing rates, a higher proportion of PLWH in our study tested positive for SARS-CoV-2 infection compared with SN participants. This suggests that PLWH may have increased susceptibility or have had greater non–HIV-related risks for SARS-CoV-2 infection. Our findings are similar to a large study of more than 280,000 people tested by the San Francisco Department of Public Health, which reported higher SARS-CoV-2 test positivity among PLWH than among SN individuals (4.5% vs 3.5%).[14] However, our findings differ from several other studies that reported similar risk of infection with SARS-CoV-2 in PLWH and SN individuals.[15–17]

The prevalence of self-reported COVID-19 symptoms and symptom severity was similar by HIV serostatus in the MWCCS. The proportion of SARS-CoV-2 positive participants who reported symptoms in our study was high (92%). However, most of the months that our surveys were conducted, SARS-CoV-2 testing was of limited availability and sought primarily by persons who were symptomatic or had a known exposure. Reasons for SARS-CoV-2 testing

TABLE 3. COVID-19 Symptom Severity Among 95 SARS-CoV-2 Positive Participants, by HIV Serostatus

	Symptom Severity Among SARS-CoV-2 Positive Participants					
	All N = 95			PLWH N = 72	SN N = 23	*P*
	% Mild or None	% Moderate	% Severe	% Severe	% Severe	PLWH vs SN
Number of symptoms reported						
0 (N = 8)	100%	0%	0%	0%	0%	NA
1–2 (N = 7)*	71%	29%	0%	0%	0%	NA
≥3 (N = 80)*	5%	26%	69%	63%	85%	0.16
≥3 *severe* symptoms	NA	NA	35%	33%	39%	0.61
Individual symptoms reported						
Headache	51%	34%	15%	17%	9%	0.43
Myalgias (muscle aches)	50%	24%	26%	24%	35%	0.57
Shortness of breath	63%	21%	16%	13%	26%	0.27
Chills	61%	26%	13%	10%	22%	0.30
Felt feverish	67%	21%	12%	8%	22%	0.13
Fever (Temp>100.4F)	81%	9%	10%	6%	22%	0.07
Loss of taste or smell	53%	21%	26%	28%	22%	0.66
Runny nose (rhinorrhea)	79%	19%	2%	3%	0%	0.21
Cough	59%	23%	18%	18%	17%	0.63
Sore throat	74%	19%	7%	7%	9%	0.87
Diarrhea	70%	12%	18%	17%	22%	0.79
Nausea or vomiting	81%	14%	5%	6%	4%	0.43
Abdominal pain	84%	10%	6%	7%	4%	0.31

*For symptom severity stratified by number of symptoms, individuals were categorized by the most severe symptom they had. So individuals with ≥3 symptoms, for example, were classified as "mild or none" if all symptoms were mild, as "moderate" if they had ≥1 moderate symptoms and no severe symptoms, and as "severe" if they had ≥1 severe symptoms.

were not collected in this study, so could not be evaluated. COVID-19 symptoms did not differ by HIV serostatus, although some previous studies reported that immunosuppression in PLWH was associated with more severe COVID-19 symptoms.[8] Several large studies have reported higher rates of COVID-19 hospitalization and mortality among PLWH than among SN cases,[7,18] raising concern that PLWH may be at increased risk of severe outcomes from COVID-19.

The impact of the pandemic on MWCCS participants was dramatic, prompting almost ubiquitous physical distancing and high reported self-isolation. Impacts on ART adherence were more modest, with disruptions in use reported by 9% of participants; however, these seemed short-lived. Only 2% of PLWH reported lower ART adherence during the pandemic compared with prepandemic, and 9% reported higher ART adherence during the pandemic. This is consistent with studies reporting some disruptions in HIV care but care engagement not being seriously disrupted[19,20] and adherence increasing in some PLWH during the pandemic.[21]

Our study had several strengths. First, the MWCCS included study sites across the United States and collected data on PLWH and similar HIV SN individuals for comparison. In addition, the same survey was administered across all study sites by well-trained staff who knew the participants well. Third, a high proportion of participants completed the survey. Finally, the survey was administered multiple times over a 5-month timeframe and, thus, was able to capture updated, real-time, and changing information about social distancing practices, self-reported COVID-19 symptoms, and SAR-CoV-2 testing. Our study also has some limitations. First, we relied on participants' self-report of COVID testing and test results because medical records were not readily available for all cases. However, people generally are likely to recall experiencing a nasopharyngeal or oropharyngeal swab, and during the early months of the COVID-19 pandemic, these specimens were unlikely to have been obtained for reasons other than COVID-19 testing. Medical records were obtained for more than half of the self-reported SARS-CoV-2 positive participants. Among self-reported cases for which test data were obtained, all cases were confirmed based on test results. MWCCS participants are used to reporting medical results, and the study has a system in place for medical information collection; however, the array of locations/testing sites and noncentralized testing methods/locations rolled out to provide access to SARS-CoV-2 testing increased the challenges associated with this process. Furthermore, some rapid SARS-CoV-2 testing sites did not provide written results and/or did not have centralized documentation of test results that could be requested, limiting confirmation. Second, we lacked information concerning access to and reasons for testing. Systematic differences in the distribution of reasons for testing could have affected the proportions of positive SARS-CoV-2 tests observed among PLWH and SN participants. We anticipate that most SARS-CoV-2 tests were prompted by the presence of COVID-19 symptoms because there were few self-reported asymptomatic COVID-19 cases; however, asymptomatic cases are underreported

everywhere. Another limitation was that we did not have confirmed information on COVID-related hospitalizations and deaths, although collection of those medical records is planned in the future. In addition, because most participants are on effective therapies, we had a limited number of severely immunosuppressed subjects, so we were not well powered to explore infection among those with very low CD4 cell counts.

In our large, prospective, multicenter US observational cohort of people with and without HIV infection, one-third of participants reported SARS-CoV-2 testing between April and September 2020, and the proportion of self-reported SARS-CoV-2 positive tests was twice as high among PLWH than SN participants. Higher SARS-CoV-2 positivity among PLWH was observed in each of the 3 administration cycles of the MWCCS COVID-19 survey and remained after adjusting for age, sex, race, and clinical research site. COVID-19 symptom type, prevalence, and severity were similar by HIV serostatus. These data suggest that PLWH may be at increased risk of acquisition of SARS-CoV-2 infection compared with HIV SN persons; however, because not all participants were tested, further research is needed to support this finding.

AUTHOR CONTRIBUTIONS

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