

**The Impact of COVID-19 Stress on ART Adherence and Unsuppressed Viral Loads
in People Living with HIV in Western Washington**

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Abstract

The Impact of COVID-19 Stress on ART Adherence and Unsuppressed Viral Loads in People Living with HIV in Western Washington

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Background: While current research finds that people living with HIV (PLWH) with suppressed HIV viral loads have similar likelihood of hospitalization and death due to COVID-19 as the general population, COVID-19 stress may lead to decreased ability for PLWH to engage in care. Personal buffers, such as social support and identity characteristics, including US citizenship or white race, may potentially moderate stress from COVID-19. The objective of this study was to determine COVID-19 stress's impact on key treatment outcomes among PLWH.

Methods: We conducted a cross-sectional study consisting of a Computer-Assisted Personal Interview (CAPI) survey administered online to PLWH in Western Washington during the COVID-19 pandemic. Bivariable and multivariable logistic regressions were used to determine the association between COVID-19 stress and (1) self-reported HIV treatment adherence or (2) HIV viral suppression. Additionally, we sought to determine if US-born status, white race, or social support were moderators of the association between COVID-19 stress and either outcome.

Results: Overall, 395 participants completed the CAPI survey during the collection period of August 1, 2020 to March 21, 2021. Thirty participants (8%) reported decreased ART

adherence and 39 participants (12.7%) had unsuppressed viral loads during social distancing. There was a borderline-significant association between COVID-19 stress score and decreased adherence (unadjusted odds ratio [OR] 1.07, 95% confidence interval [CI]: 0.99 – 1.15). Interactions between COVID-19 stress score and each potential moderator (US-born status, white race, and social support) were not significant predictors of this outcome. There were no associations of either COVID-19 stress score (OR=1.04, 95% CI 0.98 – 1.12) or the interactions between COVID-19 stress score and each of the potential moderators with the outcome of unsuppressed viral load during social distancing.

Conclusion: Overall, we found that despite stress about COVID-19, patients in Western Washington, for the most part, had good adherence to ART and were able to maintain viral suppression during the pandemic. This may be due, in part, to telemedicine and other accommodations clinics made due to social distancing to ensure access to care or to patients' own resilience in the face of adversity.

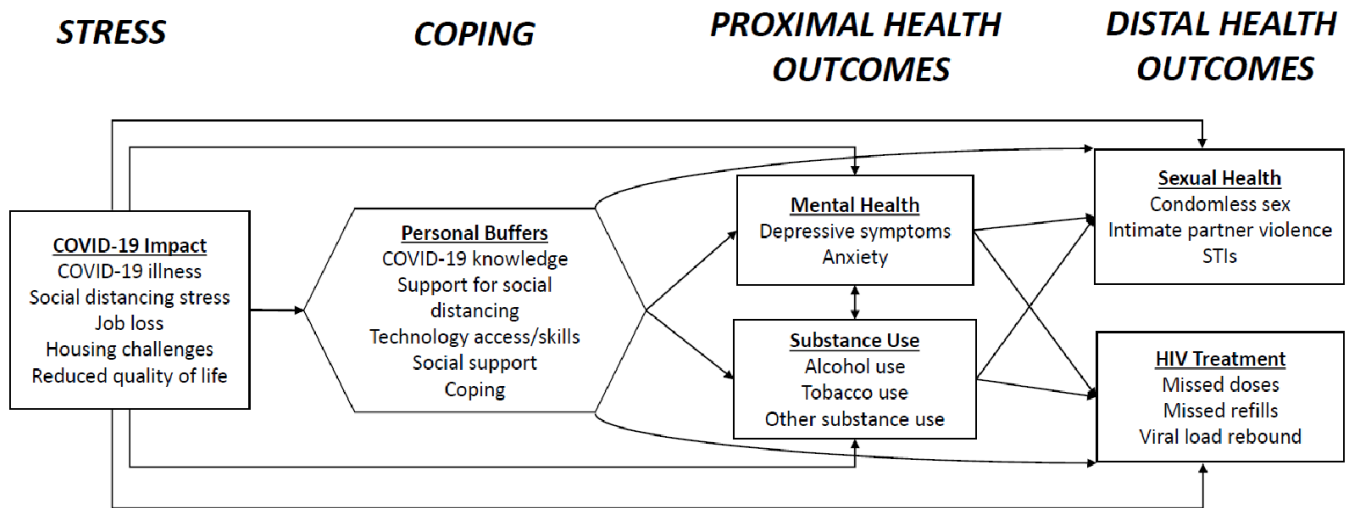
Background

In December 2019 the People's Republic of China reported the first cluster of flu-like symptoms which would later be known as the novel coronavirus, SARS-CoV-2. The first case of Coronavirus Disease 2019 (COVID-19) was reported in the United States on January 21, 2020, in Washington State and by March 1, 2020, the World Health Organization had declared COVID-19 a global pandemic.¹ To combat the pandemic, the United States implemented social distancing measures to reduce spread of the virus and to ensure that hospitals did not exceed bed capacity. Currently, social distancing remains one of the most prominent non-pharmaceutical interventions to combat COVID-19. However, this intervention has also been shown to have broad negative effects on mental health.²

Of note, negative effects on mental health produced by the COVID-19 pandemic are particularly important for people living with HIV (PLWH). While current research finds that PLWH with suppressed HIV viral loads have similar likelihood of hospitalization and death due to COVID-19 as the general population, COVID-19 stress may lead to decreased ability for PLWH to effectively engage in care.³ Of note, PLWH are vulnerable to financial and psychosocial stressors, and there is concern among HIV care providers about the impact that COVID-19 stress may have on patient care and outcomes.⁴ In particular, there is concern that the downstream effects of COVID-related stress may result in unsuppressed viral loads as a result of reduced adherence to antiretroviral therapy (ART).⁴

Our conceptual framework for this study integrates prior research on stress, coping, and health outcomes (Figure 1).^{5 6} This model posits environmental coping factors are potential moderators of the impact of stressful life events on health outcomes. In our conceptual framework, each individual's COVID-19 experience (illness if present, social distancing stress, job loss, housing challenges and reduced quality of life) is a stressful/traumatic life event. Traumatic life events are events outside the normal range of an individual's experience and can cause exceptional mental and physical stress.⁵ Personal buffers (COVID-19 knowledge, support for social distancing, technology access/skills, social support, and coping) are potential moderators of COVID-19's impact on the individual. The resulting interactions of stress and these personal buffers are posited to have downstream effects on health outcomes (mental health, substance use, sexual health, and HIV treatment).

Figure 1. Conceptual Model of COVID-19 Stress and Coping



The disruption of normalcy due to the COVID-19 pandemic is considered a traumatic event, and the health impacts of COVID-19-related stressors have been increasingly recognized. COVID-19 stress can be attributed to many factors, such as deaths of loved ones, fear of getting COVID-19, social distancing stress, job loss, housing challenges and reduced quality of life.⁷ Responses to traumatic events may include symptoms of post-traumatic stress disorder (PTSD), guilt, anxiety, grief, and depressive symptomatology.⁸ These psychosocial impairments have been shown to decrease adherence to medication.^{9 10}

Resources for coping with stressful events during the COVID-19 pandemic may have been more available to PLWH with US citizenship versus those without citizenship. Given the Trump administration’s policies on the use of government resources factoring into the naturalization process, a chilling effect was seen on the use of these resources. Studies found that these changes to federal-level immigration policy and anti-immigrant rhetoric increased fear and resulted in lack of patient engagement in both prevention and HIV care services.¹¹ Additionally, many studies show that persons of color experienced higher emotional distress and stressors than their white counterparts during the COVID-19 pandemic, often exacerbated by systemic inequities.^{12 13}

Social distancing guidelines used to limit the spread of SARS-CoV-2 directed individuals to reduce interaction with those not living within their household. Social distancing increased stress for many because of both social isolation and a reduction of positive and healthy social connection. This is important, as social support through family and community are believed to lessen the severity of mental health impacts by increasing resilience and coping strategies against stress.¹⁴ For example, for women living with HIV and depression, satisfaction with social support was found to be positively associated with better ART adherence.¹⁵

Our primary goal in this analysis was to determine if there is an association between COVID-19 stress and either self-reported HIV treatment adherence or viral suppression among people living with HIV in Western Washington. Our secondary goals were (1) to determine if US-born

status, white race, or social support score were moderators of the association between COVID-19 stress and either outcome, if present, and (2) to identify factors that were independently associated with either outcome in an exploratory analysis.

Methods

Study Population & Procedure

The study population included patients from Madison Clinic at Harborview and its four satellite clinics in Western Washington. Inclusion criteria were as follows: PLWH; 18 years of age or older; enrolment in HIV care at a Madison Clinic site; previous consent for the UW HIV patient registry; and ability to read English and complete an online survey.

This cross-sectional study consisted of a Computer-Assisted Personal Interview (CAPI) survey administered online via the Research Electronic Data Capture (REDCap) survey tool conducted from August 1, 2020 through March 21, 2021. Participants were invited via e-mail and telephone. Informed consent was obtained from all survey participants. Additional consent was requested to access clinical information to obtain viral load results and data relevant to mental health and substance use. No in-person outreach was conducted due to social distancing restrictions resulting from the continuing COVID-19 pandemic.

Clinical data were documented at routine clinic visits and were abstracted from the UW HIV Information System (UWHIS) for two 12-month periods: before COVID-19 social distancing (March 21, 2019 through March 22, 2020) and during COVID-19 social distancing (March 23, 2020 through March 23, 2021).

Predictor Measure: COVID-19 Stress Score

The main independent variable for this study's analyses was a COVID-19 stress score. The score is based on seven questions selected from two published COVID-19 related stress questionnaires available at the time of our survey, and questions were selected in order to minimize participant burden and the time needed to complete the survey.^{7 16} The resulting COVID-19 stress score was an aggregate score calculated based on seven questions inquiring the extent to which participants agreed with the following statements: "COVID-19 impacted my day-to-day life," "I am afraid of getting COVID-19," "I am afraid of spreading COVID-19," "I am afraid of being an asymptomatic carrier," "I fear stigma/discrimination from other people," "Social distancing has resulted in increased mental stress," and "I feel that I am contributing to the greater good by practicing social distancing." (Appendix). Potential responses and points given for each question were: "not at all" (0), "a little" (1), "much" (2), "a lot" (3), "extremely" (4). Scoring for the question on social distancing as a social good was reverse coded. Cronbach's alpha for this measure was 0.763.

Outcome Measures

Decrease in ART adherence was a self-reported variable asked in the CAPI survey as follows: "Please tell us if the following have changed compared to the time before the COVID-19 Pandemic: Daily adherence to ART" (Appendix A). Answers range from "Significantly decreased" (1), "Somewhat decreased" (2), "No significant change" (3), "Somewhat increased" (4), "Highly increased" (5) or "N/A" (6). The variable was dichotomized as decreased (1) if the participant answered, "Significantly decreased" or "Somewhat decreased" and not decreased (0) if answered "No significant change", "Somewhat increased", "Highly increased". For

participants who responded “N/A,” this variable was considered missing. The measure of unsuppressed HIV viral load was derived from laboratory data supplied via medical record abstraction. If any viral load during COVID-19 social distancing was found to be detectable (HIV viral load 40 copies/ml or higher), then participants were considered unsuppressed during social distancing. Participants who did not consent to chart linkage or who had no viral load results during COVID-19 social distancing had data classified as missing for the viral suppression outcome.

Moderators

We examined three covariates as potential effect modifiers of the effect of COVID-19 stress and the two outcomes of interest: social support score and identity buffers (US-born status and white race). Social support was measured using the Medical Outcomes Study Social Support Survey (MOS-SS),^{17 18 19} While the traditional MOS-SS is a 19-item survey that uses four subscales: emotional/informational support, tangible support, affectionate support, and positive social interaction. Our MOS-SS reduced the number of questions to 11 across the same subscales, to reduce participant burden. US-born status was defined based on CAPI survey responses. If a participant answered “No” to the question “Were you born outside of the United States?” then they were considered US-born (Appendix). This answer was then compared to CAPI-reported country of birth as part of the data cleaning process. Participants were considered white if they were classified as white in the UWHIS registry (based on data collected at enrolment); otherwise, participants were considered non-white.

Potential Confounders

We identified four confounders (age, gender, income, sexual orientation) based on prior studies of ART adherence and hypothesized associations with COVID-19 stress. Age was supplied via UWHIS registry information, while gender, income category, and sexual orientation were obtained via the CAPI survey.

Exploratory Predictors

An exploratory analysis was performed using covariates that were included in the study’s conceptual model as likely to affect our two outcomes. These covariates were: PHQ-9 score category for depression, GAD-7 score category for anxiety, alcohol use, and injection drug use (IDU). The PHQ-9 and GAD-7 are common measures of depression and anxiety, respectively, with derived categories corresponding to clinical diagnoses.^{20 21} Alcohol use was defined based on the CAPI question “How often do you have a drink containing alcohol?” with a recall period of the past 12 months (Appendix). Alcohol use was a self-reported variable asked in the CAPI survey as follows: “Never” (1), “Monthly or less” (2), “2 to 4 times a month” (3), “2 to 3 times a week” (4), “4 or 5 times a week” (5), “6 or 7 times a week” (6). The answer “prefer not to answer” (7) was reclassified as missing. IDU was defined based on the CAPI question “Have you EVER used any drug by injection (non-medical use only)?” (Appendix).

Missing Data

Missing data for survey participants included: 4 (1.0%) for race, 2 (0.5%) for sexual identity, 1 (0.3%) for US-born and 12 (3.0%) for social support. Numbers with missing data for the subset with viral load data only changed for social support 10 (2.6% of that subset). For the primary outcomes, 35 (9%) had missing data for ART adherence and 65 (17%) did not have data for HIV viral loads during social distancing, either because they did not consent to chart linkage (22 or 5.5%) or because no lab results were found in the chart (65 or 16.5%). Because missing

data on other covariates were rare, we used complete-case analysis for each of the two outcomes.

Statistical Analyses

Descriptive statistics were used to summarize demographic and psychosocial characteristics, ART adherence, and viral load data. Descriptive statistics were run for three groups, 1) all survey participants 2) all who had answered the question on ART adherence 3) all who had viral load data. Due to problems with model convergence, we did not use log-binomial regression. Instead, logistic regression was performed, with results reported as unadjusted or adjusted odds ratios (OR) and significance set at an alpha of .05. The three potential moderators were tested using interaction terms in models including COVID-19 stress score and the main effect of that covariate (i.e., social support, US-born status, white race). Model building was conducted using the purposive selection approach described by Bursac et al,²² with $p < 0.25$ as the criterion for forward selection, followed by iterative model fitting with retention of variables that were either associated with the outcome at $p < 0.10$ or changed the coefficient for COVID-19 stress by $\geq 15\%$.

Results

Overall, 395 participants completed the CAPI survey during the collection period of August 1, 2020, to March 21, 2021. Of these 395, 362 (91.2%) reported whether their adherence decreased during COVID-19 social distancing. In total, 373 (94%) participants agreed to use their medical records and 308 (78%) had viral load results available. Descriptive statistics of these participant groups are summarized in Table 1. Study participants were majority male (82%), gay (67%), and non-Hispanic white (65%). The distribution of participant characteristics was similar between those who did or did not report on ART adherence, consent to medical chart review, or have viral load results available.

Decreased ART Adherence

Only 30 (8.3%) of participants who reported on adherence noted that their ART adherence had decreased during COVID. In bivariable analysis, there was a borderline-significant association between COVID-19 stress score and decreased ART adherence (unadjusted odds ratio [OR] 1.07, 95% confidence interval [CI]: 0.99 – 1.15, Table 2). This association was attenuated after adjustment for age (adjusted OR=1.06, 95% CI 0.98 – 1.14). In the analysis of potential moderators, the interactions between COVID-19 stress score and each variables (i.e., US-born status, white race, and social support) were not statistically significant (p-values: 0.36, 0.85, and 0.99 respectively); adjustment for age did not change this result. In exploratory bivariable analysis, higher levels of social support and older age were both associated with a lower odds of decreased ART adherence and higher PHQ-9 categories were borderline associated with and increased odds of decreased ART adherence. In the final exploratory multivariable model, both age and social support had independent associations with decreased ART adherence (adjusted OR= 0.94, 95% CI 0.91 – 0.98; adjusted OR= 0.98, 95% CI 0.96 – 1.00).

Unsuppressed Viral Load

Of the 308 participants with HIV viral load data after social distancing, 48 (15.6%) had unsuppressed viral loads prior to social distancing and 39 (12.7%) had unsuppressed viral loads during social distancing. In bivariable analysis, there was no association between COVID-19 stress score and unsuppressed viral load during social distancing (OR=1.04, 95% CI 0.98 – 1.12). After adjustment for age, this result did not change (adjusted OR=1.04, 95%

CI 0.97 – 1.11). In the analysis of potential moderators, the interactions between COVID-19 stress score and each variables (i.e., US-born status, white race, and social support) were not statistically significant (p-value: 0.27, 0.68, 0.68 respectively); adjustment for age did not change the result. In exploratory bivariable analysis, increasing age and white race were associated with a lower odds and IDU with a higher odds of with unsuppressed viral load. Also, in bivariable analysis, higher PHQ-9 category was borderline associated with an increased odds, and higher social support was borderline associated with a decreased odds of unsuppressed viral load. In the final exploratory multivariable model, being white and reporting IDU were independently associated with unsuppressed viral load (adjusted OR= 0.29, 95% CI 0.12– 0.69; adjusted OR 3.92 CI .69 – 9.12 respectively).

Discussion

In this cross-sectional study, we tested an association between COVID-19 stress and (1) HIV treatment adherence and (2) viral suppression among people living with HIV. We found a borderline-significant association of COVID-19 stress score with decreased ART adherence, but not with unsuppressed viral load during social distancing. We found that poor outcomes were relatively rare, as only 8.3% of participants reported decreased adherence and 12.7% had unsuppressed viral loads during social distancing. While this was not a large change from the 16% of participants who had unsuppressed viral loads prior to social distancing, many participants had missing viral load data (22%) or did not consent to chart data linkage (5.3%). Exploratory analyses suggested that older participants, white participants, and those with more social support had better outcomes, while participants who reported IDU had worse outcomes.

While several published studies have investigated the effects that the COVID-19 pandemic has had on people living with HIV in terms of outcomes of infection with SARS-CoV-2, relatively few studies have investigated the impact of the COVID-19 pandemic on ART adherence and virologic suppression. In parallel with clinics in the study, clinics around the country made the switch to telehealth in consideration of COVID-19 social distancing guidelines.^{23 24} Additional research found that while there may be disruptions in care, like our study, there was no significant reporting of decreased self-reported ART adherence.²⁵ While these findings are reassuring, it is important to note that other studies did demonstrate decreased adherence to HIV medication.²⁶ Regarding viral load, a recent Italian study also found no significant changes in proportion of undetectable HIV viral load.²⁷ Our study may be the first to look at changes to HIV viral load suppression in the context of the US.

The use of self-reported ART adherence is a common, but imperfect, proxy for HIV viral load.²⁸ ²⁹ Due to potential for patients to opt out of medical chart review (22 in our case), using this ART adherence allowed for greater ability to investigate HIV treatment outcomes among our patient population. Our measure of decreased ART adherence was based on self-reported change in adherence during COVID, and as such may not be the best proxy for overall ART adherence, especially among participants whose adherence was already poor prior to the COVID-19 pandemic. Of note, of the 29 participants who had decreased ART adherence only 7 reported having poor or very poor ability to take their medication and only 9 had unsuppressed viral loads during social distancing. It may be informative to triangulate additional self-reported adherence measures collected in the CAPI survey and the chart data with unsuppressed viral load measure, to determine which self-reported adherence measure best correlates with unsuppressed viral load. In light of this potentially weak relationship between self-reported adherence and viral load suppression, our finding that increased

COVID-19 stress score is not significantly associated with unsuppressed viral load may be more indicative of the strength of current ART regimens, which are relatively robust to missed doses. Of those with unsuppressed viral loads during social distancing, approximately 74% reported that they had missed three or less doses during the past 7 days and 64% had missed 15 or less doses during the past 3 months. Current ART regimens have been reported to still result in viral suppression despite missing 2-3 doses per week.^{30 31}

We used US-born as a proxy for citizenship, which was not collected in the CAPI survey. US-born status was not found to moderate the relationship of COVID-19 stress score with decreased ART adherence. Originally, it was hypothesized that those who were foreign born may experience added stress and lack of services based on discriminating policies against the use of government resources, resulting in poor HIV treatment adherence. While we did not identify a significant interaction, it is important to note that foreign-born status was not disaggregated by region. Of the 49 foreign-born persons, 11 were from Canada and Europe. Additionally, this measure does not account for time in the country and actual citizenship status. For example, those who may have immigrated at younger ages may have different citizenship status than those who immigrated when older. White race was also not a moderator of COVID-19 stress, showing at least in our population that any impact of fear of COVID-19, as captured by our COVID-19 stress score, on ART adherence may not have differed greatly for persons of color. Importantly, our power to test either US-born status or white race as moderators was very limited due to the relatively small sample size and infrequent outcomes. However, in line with our hypothesis in bivariable analysis and our exploratory model white race was a stress buffer during the COVID-19 pandemic, where white race was found to be a significant predictor of unsuppressed viral load during social distancing.

While social support was found to not moderate the relationship of COVID-19 stress score with either of the outcomes of decreased ART adherence or unsuppressed HIV viral load during social distancing, it was a significant predictor for ART adherence and borderline significant predictor for unsuppressed viral loads in bivariable analysis, with increasing social support associated with a lower odds of adverse outcomes. This supports literature findings that social support may have a protective effect on PLWH and helps ensure adequate ART adherence.³²
^{33 15} Our exploratory analyses also found expected associations of age with both outcomes, following prior research findings that older adults have better ART adherence.³⁴ Although our power was limited for multivariable analysis, our estimates for associations with depressive symptoms were also in expected directions, with higher estimated odds of decreased ART adherence and unsuppressed viral load among those with moderate to severe depressive symptoms. Finally, we found an expected association between IDU and poor viral suppression.

This study is one of few to have evaluated the impact of the COVID-19 pandemic on both self-reported adherence and viral load suppression. As such, it has considerable strength. Despite this, our study had several limitations. First, we did not measure self-reported ART adherence prior to the pandemic, which does not allow for a baseline against which to measure a self-reported decrease in adherence. Second, our COVID-19 stress score had a limited number of items, focused more on fear of COVID-19 than on stress from other sources, and has not been validated against other scores. Third, results may not be generalizable to other clinic populations and to patients with language and technology barriers or those experiencing homelessness. Use of CAPI and other online methods has been found to result in selection bias against older aged individuals (45-64) and non-white groups;³⁵ that said, our study

included many older and non-white individuals and demographic characteristics did not differ significantly from those of the clinic population from which we recruited. Fourth, this was a cross-sectional study, and therefore causal inference is not possible. Fifth, we had a limited sample size due to funding constraints.

Overall, we found that despite stress about COVID-19, patients in Western Washington, for the most part, had good adherence to ART and were able to maintain viral suppression during the pandemic. This may be due, in part, to telemedicine and other accommodations clinics made due to social distancing to ensure access care or to patients' own resilience in the face of adversity. Qualitative analysis of in-depth interviews of a subset of our survey participants may shed light on the reasons for our findings. Meanwhile, our findings add to the current body of literature on the impact of the COVID-19 pandemic on PLWH.

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Table 1. Patient characteristics

Characteristics		Total Eligible Population	Reported ART adherence	Reported HIV viral load during Social Distancing
		(n=395)	(n= 360)	(n= 308)
Gender*	Female	59 (15%)	47 (13%)	14.61 (15%)
	Male	322 (82%)	300 (83%)	250 (81%)
	Non-Binary/Genderqueer	14 (4%)	13 (4%)	13 (4%)
Sexuality	Gay	262 (66%)	245 (68%)	207 (67%)
	Heterosexual	69 (17%)	58 (16%)	49 (16%)
	Bisexual	40 (10%)	36 (10%)	31 (10%)
	Queer	22 (6%)	20 (6%)	19 (6%)
	Don't Know	2 (1%)	1 (0%)	2 (1%)
Age	18-29	33 (8%)	30 (8%)	27 (9%)
	30-49	195 (49%)	174 (48%)	149 (48%)
	50+	167 (42%)	156 (43%)	132 (43%)
Race/Ethnicity†	Native American	15 (4%)	12 (3%)	13 (4%)
	Asian	27 (7%)	26 (7%)	23 (7%)
	Black	51 (13%)	46 (13%)	39 (13%)
	Hawaiian Native	8 (2%)	6 (2%)	5 (2%)
	Latino	34 (9%)	32 (9%)	26 (8%)
	White	256 (65%)	235 (65%)	199 (65%)
	Unknown	4 (1%)	3 (1%)	3 (1%)
Foreign born	Yes	51 (13%)	313 (87%)	39 (13%)
	No	343 (87%)	46 (13%)	268 (87%)
			1 (0%)	
Yearly Income‡	<\$40,214	258 (65%)	230 (64%)	198 (64%)
	\$40,215 - \$75,049	51 (13%)	49 (14%)	39 (13%)
	\$75,050 – \$117,801	25 (6%)	25 (7%)	20 (6%)
	>\$117,801	61 (15%)	56 (16%)	51 (17%)
Social Support Score Quintiles	1 (lowest)	75 (19%)	66 (18%)	63 (20%)
	2	80 (20%)	74 (21%)	59 (19%)
	3	75 (19%)	70 (19%)	64 (21%)
	4	73 (18%)	66 (18%)	59 (19%)
	5 (highest)	12 (3%)	9 (3%)	54 (18%)

ART Adherence	No Decrease in Adherence	330 (84%)	330 (84%)	261 (85%)
	Decreased ART Adherence	30 (8%)	30 (8%)	22 (7%)
	Missing	35 (9%)	N/A	25 (8%)
Detectable Viral Load During Social Distancing	No Detectable Viral Load	NA	N/A	269 (72%)
	Detectable Viral Load	NA	N/A	39 (10%)

* Any participant who identified themselves as trans were aggregated with corresponding gender. Transmen were aggregated with men and transwomen were aggregated with women.

† Anyone who identified as Hispanic/Latino ethnicity regardless of race/ethnicity category was categorized as Latino

‡ Income categories were based on reported Household Income Quintiles for King County in 2018.³⁶

Table 2. Factors Associated with Decreased Adherence among 360 People Living with HIV who Reported on the Measure of Change in ART Adherence

Variable	Unadjusted Analysis		Model 1*		Model 2†	
	OR (95% CI)	P value	AOR (95% CI)	P value	AOR (95% CI)	P value
COVID-19 stress score	1.07 (0.99,1.15)	0.073	1.06 (0.98,1.14)	0.126	1.02 (0.94,1.11)	0.613
Age	0.95 (0.91,0.98)	0.001	0.95 (0.91,0.98)	0.002	0.94 (0.91,0.98)	0.002
Gender						
Female	Referent	0.829				
Male	0.73 (0.26,2.02)					
Non-binary	0.70 (0.07,6.58)					
Sexual orientation						
Gay, Homosexual, or Lesbian	Referent	0.816				
Straight or Heterosexual	0.55 (0.16,1.91)					
Bisexual	0.92 (0.26,3.25)					
Queer	1.13 (0.25,5.18)					
Income						
<40,214	Referent	0.316				
40,215 - 75,049	0.37 (0.08,1.6)					
75,050 - 117,801	0.36 (0.05,2.76)					
>117,801	0.49 (0.14,1.67)					
US-born status	0.95 (0.32,2.86)	0.929				
White race	0.65 (0.31,1.4)	0.272				
Social support	0.98 (0.96,0.99)	0.012			0.98 (0.96,1.00)	0.033
GAD-7 score						
None	Referent					
Mild	3.94 (1.19,13.05)	0.118				
Moderate	2.2 (0.53,9.13)					
Severe	3.5 (1.09,11.21)					
PHQ-9 score						
None	Referent	0.097				0.230
Mild	3.12 (0.63,15.43)				2.08 (0.4,10.93)	
Moderate	3.88 (0.78,19.29)				2.84 (0.54,14.96)	
Moderately severe	8.34 (1.65,42.21)				6.24 (1.11, 35.01)	
Severe	5.56 (1.11,27.81)				3.58 (0.66, 19.61)	
Injection Drug Use	1.87 (0.85,4.13)	0.121				

Often drink alcohol last 12 months						
Never	Referent	0.248				0.291
Monthly or less	0.66 (0.22,1.99)				0.57 (0.18,1.8)	
2 to 4 times a month	1.99 (0.8,4.99)				3.58(0.66,19.61)	
2 to 3 times a week	0.56 (0.12,2.64)				0.35 (0.07,1.83)	
4 or 5 times a week	0.41 (0.05,3.36)				0.4 (0.05,3.39)	
6 or 7 times a week	0.47 (0.06,3.84)				0.4 (0.05,3.51)	

AOR = adjusted odds ratio, CI = confidence interval, OR = odds ratio

* Model adjusted for age

† Model adjusted for Age, Social Support, PHQ-9, how often drank alcohol in last 12 months

Table 3. Factors Associated with Unsuppressed Viral Load during COVID-19 Social Distancing Among 308 People Living with HIV with Measured HIV viral loads

Variable	Unadjusted Analysis		Model 1*		Model 2†	
	OR (95% CI)	P value	AOR (95% CI)	P value	AOR (95% CI)	P value
COVID-19 stress score	1.04 (0.98, 1.12)	0.217	1.04 (0.97, 1.11)	0.308	1.04 (0.96,1.12)	0.308
Age	0.96 (0.94,0.99)	0.017	0.97 (0.94,0.99)	0.022	0.98 (0.95,1.02)	0.289
Gender						
female	Referent	0.728				
male	0.77 (0.32,1.87)					
nonbinary	0.45 (0.05,4.06)					
Sexual orientation						
Gay, Homosexual, or Lesbian	Referent	0.873				
Straight or Heterosexual	0.76 (0.28,2.08)					
Bisexual	1.28 (0.45,3.62)					
Queer	0.78 (0.17,3.59)					
Income						
<40,214	Referent	0.380				
40,215 - 75,049	0.47 (0.14,1.61)					
75,050 - 117,801	0.62 (0.14,2.82)					
>117,801	0.48 (0.16,1.42)					
US-born status	1.09 (-0.38,2.55)	0.146			4.13 (0.88,19.44)	0.073
White race	0.45 (0.23,0.89)	0.022			0.29 (0.12,0.69)	0.005
Social support	0.98 (0.97,1)	0.094			0.99 (0.97,1.01)	0.378
GAD-7 score						
none	Referent	0.170				
mild	1.81 (0.67,4.95)					
moderate	3.03 (1.05,8.71)					
severe	2.36 (0.94,5.93)					
PHQ-9 score						
none	Referent	0.052				0.0385
mild	4.19 (1.34,13.09)				3.26 (0.97,11)	
moderate	1.8 (0.5,6.45)				0.77 (0.19,3.16)	
moderately severe	4.41 (1.19,16.28)				2.81 (0.65,12.25)	
severe	1.74 (0.41,7.36)				1.02 (0.22,4.74)	

Injection Drug Use	3.09 (1.52,6.28)	0.002			3.92 (1.69,9.12)	0.002
Often drink alcohol last 12 months						
Never	Referent	0.549				
Monthly or less	0.74 (0.33,1.69)					
2 to 4 times a month	0.64 (0.25,1.66)					
2 to 3 times a week	0.46 (0.13,1.68)					
4 or 5 times a week	N/A					
6 or 7 times a week	0.25 (0.03,2.04)					

AOR = adjusted odds ratio, CI = confidence interval, OR = odds ratio

* Model adjusted for age

† Model adjusted for Age, US-born status, being white, Social Support, PHQ-9, IDU

Appendix

Predictor		
<p>COVID-19 Stress Score</p>	<p>CAPI Questionnaire</p>	<p><u>Questions:</u></p> <ul style="list-style-type: none"> ● COVID-19 impacted my day-to-day life ● I am afraid of getting COVID-19 ● I am afraid of spreading COVID-19 ● I am afraid of being an asymptomatic carrier ● I fear stigma/ discrimination from other people (e.g., people treating you differently because of your identity, having symptoms, or other factors related to COVID-19), ● I feel that I am contributing to the greater good by practicing social distancing ● Social distancing has resulted in increased mental stress <p><u>Responses:</u> (0) “not at all”, (1)“a little”, (2)“not much”, (3)“a lot”, and (4)“extremely”.</p> <p><u>Definition:</u> A continuous aggregate score of above COVID-19 Stress Score question responses. (Range: 0-28). Cronbach alpha: 0.7655</p>
Primary Outcomes	Source/Test	Rating/Coding for Analysis
<p>HIV Treatment Outcome: Self-Reported Decreased ART Adherence:</p>	<p>CAPI Questionnaire</p>	<p><u>Questions:</u></p> <p>The following questions specifically address factors around your HIV treatment. Please tell us if the following have changed compared to the time before the COVID-19 Pandemic:</p> <p>“Daily adherence to ART”</p> <p><u>Responses:</u> “Significantly decreased”, “Somewhat decreased”, “No significant change “, “Somewhat increased”, “Highly increased “</p>

		<p><u>Definition:</u> Dichotomize (1/0) - decreased (1) if answered “Significantly decreased” or “Somewhat decreased” and not decreased (0) if answered “No significant change “, “Somewhat increased”, “Highly increased”</p>
HIV Treatment Outcome: Unsuppressed HIV Viral Load During Social Distancing	UW HIV Information System (UWHIS)	<p><u>Measure:</u> Measured laboratory plasma viral load. Detectable if 40 copies/ml. <u>Definition:</u> If at any point during the COVID-19 pandemic they have a detectable viral load. Detectable was considered any viral load with limit of detection of HIV viral load 40 copies/ml or higher.</p>
Moderators		
US-born Status	CAPI Questionnaire	<p><u>Question:</u> Were you born outside of the United States? (Y/N) <u>Definition:</u> if answered no then US-born</p>
Race/Ethnicity	UW HIV patient registry	<p><u>Measure:</u> Race categories: American Indian, Asian, Black, Hawaiian or Pacific Islander, White. If ethnicity is marked as Hispanic, then Race is Hispanic/Latino. <u>Definition:</u> If a participant’s race/ethnicity was defined as white then white, if not then patient was considered non-white</p>
Social Support Score	CAPI Questionnaire	<p><u>Questions:</u> Social Support from friends, family, and others can be very important in times of stress. Please read each statement carefully and indicate whether you agree or disagree.</p> <ul style="list-style-type: none"> ● There is a special person who is around when I am in need. ● There is a special person with whom I can share my joys and sorrows. ● My family really tries to help me. ● I get the emotional help and support I need from my family. ● I have a special person who is a real source of comfort to me. ● My friends really try to help me. ● I can talk about my problems with my family.

		<ul style="list-style-type: none"> ● I have friends with whom I can share my joys and sorrows. ● There is a special person in my life who cares about my feelings. ● My family is willing to help me make decisions. ● I can talk about my problems with my friends. <p><u>Responses:</u> (1) “Very strongly disagree”, (2) “Strongly disagree”, (3) “Mildly disagree”, (4) “Neutral”, (5) “Mildly agree”, (6) “Strongly agree”, (7) “Very strongly agree”</p> <p><u>Definition:</u> A continuous aggregate score of above Social Support Score question responses. (range: 0-77). Cronbach alpha: 0.9452</p>
Confounders		
Gender	CAPI Questionnaire	<p><u>Question:</u> Which of the following gender identities do you identify most closely with?</p> <p><u>Responses:</u> “Female”, “Male”, “Trans female/ Trans woman”, “Trans male/ Trans man”, “Genderqueer/ Gender non-conforming”, “Different identity”</p> <p><u>Definition:</u> Female if answered female or transwoman. Male if answered male or trans male. non-binary/gender queer if answered “Genderqueer/ Gender non-conforming” or “Different identity”</p>
Sexual Orientation	CAPI Questionnaire	<p><u>Question:</u> Because sexual identity may influence health behaviors and overall health, please indicate which of the following terms best describes you. Do you think of yourself as?</p> <p><u>Responses:</u> “Gay, Homosexual, or Lesbian”, “Straight or Heterosexual”, “Bisexual”, “Queer”, “Something else”, “Don't know”</p>
Income Category	CAPI Questionnaire	<p><u>Question:</u> How much money do you earn in a month before taxes are taken out? Please estimate in whole dollars: monthly salary</p> <p><u>Definition:</u> monthly salary * 12. Categories are based off of WA income brackets as</p>

		follows: <40,214, 40,215 - 75,049, 75,050 - 117,801, >117,801
Age	UWHIS	.
Exploratory Variables		
How often drink alcohol	CAPI Questionnaire	<p><u>Question:</u> during the <u>PAST TWELVE MONTHS</u>. How often do you have a drink containing alcohol?</p> <p><u>Responses:</u></p> <p>1 Never 2 Monthly or less 3 2 to 4 times a month 4 2 to 3 times a week 5 4 or 5 times a week 6 6 or 7 times a week 7 Prefer not to answer</p>
Injection Drug Use (IDU)	CAPI Questionnaire	<p><u>Question:</u> Have you <u>EVER</u> used any drug by injection (non-medical use only)?</p> <p><u>Responses:</u> Yes or No</p>