

Factors Associated with ART Adherence for Prevention and Treatment among Sexual Minority Men: Integrating Traditional and Machine Learning Approaches

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Background

Antiretroviral therapy (ART) for Prevention and Treatment will Achieve EHE goals if...

- They reach key groups experiencing HIV disparities (e.g., sexual minority men)
- 2. Once the medications reach these groups, the medications are taken with optimal adherence

Boussari et al., 2015, BMC Med Res Methodology; Chen et al., 2014, PLoS One; Fauci et al., 2019, JAMA

Prior Biomedical Prevention and Treatment Research

- Prior research has identified determinants of PrEP adherence and ART for treatment adherence among sexual minority men
 - Opportunity: examining determinants of adherence from a status neutral perspective
- Prior research has largely relied on traditional regression modeling approaches
 - Opportunity: integrating machine learning approaches which may have unique benefits and yield unique insights

Arnold et al., 2014, Culture, Health & Sexuality; Barrington et al., 2019, Ethnicity & Health; Biello et al., 2016, AIDS Care; Blashill et al., 2020, Arch Sex Behav; Bogart et al., 2010, Ann Behav Med; Edeza et al., 2021, AIDS Care; Harkness et al., 2018, AIDS & Behavior; Harkness et al., 2022, Journal of Behav Med; Stekler et al., 2018, AIDS Educ Prev



Current Study

 What are the determinants of ART adherence, regardless of whether it is being taken for prevention or treatment, among sexual minority men in South Florida?





- Secondary analysis of community survey in South Florida
- Eligible for analysis (N=365):
 - Lived in greater Miami area
 - 18 years +
 - Identified as cisgender male
 - Identified as gay, bisexual, or another sexual minority identity
 - Currently prescribed ART either as prevention or treatment







- Mean age: 39.4 years (range: 18-67)
- Most identified as Latino (51%) or Black (15.6%)
- Similar proportion of participants taking ART for treatment (N=185) vs. PrEP (N=180)
- Most reported "optimal adherence" (77.8%)







Possible Determinants

- Age
- Sexual orientation
- Race/ethnicity
- PrEP vs. Treatment
- Depression (PHQ-4)
- Anxiety (PHQ-4)
- Traumatic experience
- Self-esteem
- Condomless sex
- Alcohol use
- Substance use

Adherence

In the last 4 weeks, how good a job did you do at taking [your medicine/PrEP] in the way you were supposed to?

Poor Fair Good Very Good Excellent

Kroenke et al., 2009, Psychosomatics; Sheehan 2014; Robins et al., 2001, Pers Soc Psychol Bull; Smith et al., 2010, Arch Intern Med; Feldman et al., 2013, AIDS Beh; Lu et al., 2008, AIDS Beh





- Traditional approach: Logistic Regression
- Machine learning approaches:
 - LASSO
 - Multivariate Adaptive Regression Spline (MARS)
 - Classification and Regression Trees (CART)
 - Random Forest



- Logistic regression: Gives you an interpretable odds ratio and a significance level. Assumes that there are linear trends (in the logit space).
- **LASSO:** Gives you odds ratios but all the ORs are shrunk relative to logistic. Results more replicable (shrinks unimportant predictors to zero).
- **MARS:** Also gives an odds ratio, but without presuming a linear relationship between predictor and outcome.



- **CART:** Builds a "Classification Tree" with subgroups of people who are similar on the outcome (i.e., adherence) based on combinations of predictors.
- **Random Forest:** Builds trees using random samples of the data and random subsets of the variables. Averages the findings across hundreds of classification trees to identify important predictors of the outcome.



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Results: Traditional Logistic Regression

Logistic Model

Term	Estimate	Lower 95% CL	Upper 95% CL	p.value
(Intercept)	2.05	1.17	3.68	0.014
Race/Ethnicity: Hispanic or Latino	2.47	1.29	4.74	0.006
Race/Ethnicity: Another Race/Ethnicity	2.55	0.69	12.35	0.189
Race/Ethnicity: White	4.04	1.89	8.84	< 0.001
Anxiety Symptoms	0.83	0.73	0.95	0.007



Results: LASSO



Results: MARS

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Depression-Race/ethnicity-Used substances ART for tx-Traumatic event-Sexual orientation-High self-esteem-4+ drinks per day Condomless sex-Anxiety-Age 0.35 0.40 0.45 0.50 One minus AUC after permutations (higher indicates more important)

Results: CART





Results: CART



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Results: CART

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Results: Random Forest #ADHERENCE2023



Results

Variables Identified as Important in Predicting Adherence Across Five Types of Models.

Important Variables	CART	Random	LASSO	MARS	Logistic
Identified in Model		Forest			Regression
(AUC ROC)	(0.518)	(0.618)	(0.590)	(0.541)	(0.631)
Depression Symptoms	2	6	8	1	-
Anxiety Symptoms	6	8	6	-	2
Race/Ethnicity	1	1	1	2	1
Substance Use	3	3	4	3	-
Alcohol Use	4	5	3	-	-
Sexual Orientation	5	11	9	-	-
Age	7	2	10	-	-
Self-Esteem	-	4	2	-	-
Condomless Sex	-	9	5	-	-
Treatment vs. PrEP	-	10	7	-	-
Traumatic Event	-	7	11	-	-

*Note: Lower values refer to more important predictors within the model (i.e., 1 refers to most important predictor in model)

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Limitations

- Limited pool of potential determinants; secondary analysis
- Cross sectional data
- Determining how best to integrate disparate findings across modeling approaches



Next Steps & Implications

- Taking ART for prevention vs. treatment not an important predictor of adherence suggests utility of
 - (1) adapting treatment adherence counseling for PrEP adherence and
 - (2) taking a status neutral approach in developing and implementing adherence counseling



• Machine learning methods are innovative in the HIV adherence field; can help to reduce the limitations associated with traditional modeling approaches (interdisciplinary collaboration)



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- Center for HIV and Research in Mental Health (CHARM), led by Dr. Steve Safren and funded by NIMH (P30MH116867)
- NIMHD (K23MD015690; PI Harkness)



Table 1. Participant Descriptive Information.

	ART	PrEP	Overall
	(N=185)	(N=180)	(N=365)
Adherence Group		X =7	
Suboptimal	47 (25.4%)	34 (18.9%)	81 (22.2%)
Optimal	138 (74.6%)	146 (81.1%)	284 (77.8%)
Age	· · ·	. ,	. ,
Mean (SD)	42.2 (11.8)	36.6 (10.9)	39.4 (11.7)
Median [Min, Max]	42.0 [18.0. 64.0]	34.0 [19.0, 67.0]	36.0 [18.0, 67.0]
Sexual Orientation			
Gav	160 (86.5%)	170 (94.4%)	330 (90.4%)
Another Sexual Orientation	25 (13.5%)	10 (5.6%)	35 (9.6%)
Race/Ethnicity		. ,	. ,
Black	39 (21.1%)	18 (10.0%)	57 (15.6%)
Hispanic or Latino	89 (48.1%)	97 (53.9%)	186 (51.0%)
Another Race/Ethnicity	6 (3.2%)	8 (4.4%)	14 (3.8%)
White	51 (27.6%)	57 (31.7%)	108 (29.6%)
Condomless Sex	. ,		. ,
No	65 (35.1%)	43 (23.9%)	108 (29.6%)
1 or 2 times	25 (13.5%)	46 (25.6%)	71 (19.5%)
3 to 5 times	24 (13.0%)	37 (20.6%)	61 (16.7%)
6+ times	71 (38.4%)	54 (30.0%)	125 (34.2%)
Anxiety			
Mean (SD)	1.83 (1.92)	1.36 (1.64)	1.60 (1.80)
Median [Min, Max]	1.00 [0, 6.00]	1.00 [0, 6.00]	1.00 [0, 6.00]
Depression Score			
Mean (SD)	1.54 (1.73)	1.06 (1.41)	1.30 (1.59)
Median [Min, Max]	1.00 [0, 6.00]	0 [0, 6.00]	1.00 [0, 6.00]
Traumatic Event			
No	91 (49.2%)	118 (65.6%)	209 (57.3%)
Yes	94 (50.8%)	62 (34.4%)	156 (42.7%)
Heavy Drinking (4+ drinks/day)			
Never	68 (36.8%)	32 (17.8%)	100 (27.4%)
Less than once/month	36 (19.5%)	39 (21.7%)	75 (20.5%)
1-3 times/month	32 (17.3%)	62 (34.4%)	94 (25.8%)
1-2 times/week	36 (19.5%)	28 (15.6%)	64 (17.5%)
More than 3 times/week	13 (7.0%)	19 (10.6%)	32 (8.8%)
Substance Use			
Never	66 (35.7%)	101 (56.1%)	167 (45.8%)
<once month<="" td=""><td>18 (9.7%)</td><td>35 (19.4%)</td><td>53 (14.5%)</td></once>	18 (9.7%)	35 (19.4%)	53 (14.5%)
1-3 times/month	36 (19.5%)	29 (16.1%)	65 (17.8%)
1+ times/week	65 (35.1%)	15 (8.3%)	80 (21.9%)
I have high self-esteem			
1 not very true of me	12 (6.5%)	7 (3.9%)	19 (5.2%)
2	20 (10.8%)	12 (6.7%)	32 (8.8%)
3	54 (29.2%)	49 (27.2%)	103 (28.2%)
4	53 (28.6%)	65 (36.1%)	118 (32.3%)
5 very true of me	46 (24.9%)	47 (26.1%)	93 (25.5%)

