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The Interplay of Sociodemographic Factors on Virologic Suppression Among a U.S. Outpatient HIV Clinic Population

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Abstract

Understanding challenges to virologic suppression is essential to optimizing health outcomes among individuals with HIV. This cross-sectional behavioral assessment was conducted among 514 individuals presenting at an urban U.S. HIV clinic between June and September 2007. The majority of the sample was African American and male, with a mean age of 42 years. Most of the sample was receiving highly active antiretroviral therapy (HAART), and the majority of those had suppressed viral loads (HIV viral loads less than 400 copies per milliliter). By logistic regression analyses, African American/other minorities had 2.9 increased odds, those less than high school degree had 2.3 increased odds, those who were receiving ritonavir-boosted protease inhibitor therapy had 1.4 increased odds, and those who had expressed symptoms indicative of depressive disorders had 2.5 increased odds of having unsuppressed viremia as compared to Caucasians, those with more education, receiving non-nucleoside reverse transcriptase inhibitor-based therapy, and who had minimal depressive symptoms, respectively. These findings signify the importance of individualized interventions to enhance virologic suppression, both based on medication choices and individual characteristics.

Introduction

An estimated 56,000 new cases of HIV occur annually in the United States.[1] With the advances in antiretroviral medications, HIV has been transformed into a manageable chronic disease for those with access to treatment.[2,3] Despite these advances, AIDS-related deaths have remained stable and patients too often present to care late in the course of their HIV disease with an AIDS defining illness or immunologic AIDS.[1,2] Furthermore, there are continued disparities in the management of individuals with HIV who are engaged in medical care. Providers are often faced with significant challenges regarding retention, adherence to therapy, and management of comorbid illnesses such as psychiatric disorders and substance abuse, particularly as HIV disproportionally affects individuals of low socioeconomic status.

In efforts to improve medical care management, sociodemographic characteristics and psychosocial stressors have been examined as potential barriers to engagement and adherence to medical care and treatment in the United States.[4–8] Continued engagement in medical care is paramount to survival with HIV infection.[9,10] As successful therapies have become available, new challenges have arisen regarding effective timing and type of therapy for all patients. As newer medications have been developed, the necessary adherence threshold has fortunately declined.[11,12] However, disparities in the provision of care among lower income, African Americans, Latinos, and drug-using populations receiving highly active antiretroviral therapy (HAART) remains prevalent.[13,14] Specifically, women and African Americans with low annual income and depressive symptoms have been reported to adhere to HAART less successfully, and may suggest a preconceived bias in treatment choices by providers.[7,8,15]

HIV medical outcomes are affected by the complex lives and environments in which individuals live. Publicly funded infrastructures have been established to ensure access to medical and ancillary care services for individuals with HIV in the United States. These infrastructures attempt

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to overcome some of the substantial barriers to care and treatment of HIV. In order to optimize health outcomes, understanding the sociodemographic characteristics and variations in treatment are necessary. This study was conducted to increase understanding of some of the barriers, both sociodemographics and treatment practices, to successful management of HIV in a publicly-funded urban, midwestern U.S. medical center.

Methods

This was a cross-sectional study of sociodemographic and treatment factors, and their effect on HIV viral load. As part of standard-of-care, all patients with HIV who attended the Washington University HIV Clinic (WU HIV Clinic) in St. Louis, Missouri, completed a behavioral assessment during regular clinic visits, in which less than 3% ($n = 15$) of the clinic population surveyed refused to complete the interview. These assessments were conducted while individuals were waiting to be seen by their health care providers. All patients who presented in the clinic and had completed assessments between June and September 2007 were eligible to participate. This study was approved by Washington University School of Medicine Human Research Protection Office.

WU HIV Clinic is the major provider of HIV clinical care and supportive services to people living with HIV/AIDS in the St. Louis region. A comprehensive range of services is available for HIV/AIDS patients served at WU HIV Clinic, including: laboratory services, medical case management, mental health care, patient education, peer treatment adherence counseling, support groups, transportation, childcare, and access to clinical trials research.

The behavioral assessment was conducted by a trained interviewer with each patient as they waited for their provider. These assessments included measures of demographic characteristics (race/ethnicity, employment, education, and annual income), self-reported medication adherence using the 4-day AIDS Clinical Trial Group adherence instrument,[16] and depressive symptomatology as measured by the Patient Health Questionnaire (PHQ-9).[17] The PHQ-9 is used to calculate severity and symptom counts that signify major depressive disorder (MDD) and other depressive disorders (ODD).[18] Self-reported medication adherence was analyzed using 95% adherence cutoff as calculated by the number of pills prescribed the previous 4 days and the number reported taken, which were then dichotomized at less than 95% and greater than 95% to adhere to prescribed standards.[18]

Current CD4 cell count, plasma HIV RNA level, use and types of prescribed antiretroviral therapies were collected at time of the visit. HAART was defined as the use of at least three drugs from two different antiretroviral drug classes, Protease inhibitor (PI) or non-nucleoside reverse transcriptase inhibitor (NNRTI), or the use of more than three nucleoside reverse transcriptase inhibitors (NRTI). The number of the regimen was collected and dichotomized to first line of therapy or second line and greater. As it is expected that individuals who receive more than second lines of therapy have increased difficulty managing their care, this was included to assess any related factors in the analyses. Participants receiving HAART were categorized into NNRTI-based or PI-based therapies. There were only five individuals receiving an unboosted PI-based regimen. The participants receiving three NRTIs ($n = 10$) were excluded from therapy-based analyses. Additional analyses were conducted among individuals having a CD4 cell count less than 350 cells/mm^3 to examine factors among individuals who, based on U.S. guidelines are to be receiving HAART, and regardless of prescription continue to have low CD4 cell counts.[17] Virologic suppression was defined as having an HIV RNA level of less than 400 copies per milliliter. Previous work by our group has identified this threshold to be highly correlated with subsequent virologic failure.[19]

Statistical analyses

Descriptive analyses were conducted to describe the sample. Bivariate analyses (*t* tests and analysis of variance [ANOVA]) were used to assess differences in the sample by gender and HIV-related measures. Differences in gender were hypothesized to exist based on previous research that found women to be less adherent to medication.[21] Tukey *post hoc* analyses were used for pair-wise comparisons in conjunction with the ANOVAs. Logistic regression analyses were conducted, the final model was presented as the best fit using likelihood ratios. Analyses related to virologic suppression were conducted only with individuals who were on HAART (73%), as it is expected that those with prescriptions have unsuppressed viremia or do not currently meet recommended guidelines for treatment.[19] HIV viral loads were used as a proxy for medication adherence. HIV viral loads were dichotomized (less than 400 copies per milliliter and greater than 400 copies per milliliter) to allow for binary logistic regression analyses to be conducted in efforts to determine factors that serve as predictors of effective virologic suppression (race, gender, employment status, education level, depressive symptomatology). Education levels were dichotomized: less than high school graduate/GED or more than a high school degree. Employment status was dichotomized into unemployed (including receiving disability benefits) and employed (part- or full-time). Annual income was dichotomized into less than and greater than $10,000. Depression severity was dichotomized to those who expressed symptoms of major or other depressive disorders (MDD/ODD) within the past 2 weeks and those who did not. Age was categorized for regression analyses (18–34, 35–49, older than 50 years). The 4-day recall of medication adherence was dichotomized as less than 95% and more than 95% adherent. All tests were two-tailed and $p < 0.05$ was considered significant. Data analyses were performed using SPSS software (version 16.0; SPSS Inc., Chicago, IL).

Results

A total of 514 individuals completed the assessments between June and September 2007. The majority of the sample was male (68%) and African American (59%), which is representative of the clinic population. There were few non-African American minorities ($n = 46$) and individuals who reported their race as "other," therefore race was dichotomized into Caucasian versus African Americans/ other racial/ ethnic minorities. The mean age of the clinic-based sample was 41.8 years. A significant portion of the sample completed a college or graduate degree (42%). A large proportion of the sample reported an annual salary of less than $10,000 (47%), while 16% reported more than $30,000. There were partici-

pants who refused to respond to annual income ($n = 44$). Minimal data were missing among the employment status ($n = 1$). Income was not used in the final analyses due to the correlation with employment status among this population, (Pearson's $r = 0.47$; $p < 0.001$). Employment status rather than income was used. Table 1 depicts additional sample details. There were no gender differences regarding CD4 cell count or strata, yet women were receiving HAART less frequently than men (65% versus 76%; $p = 0.007$). As such, women had higher mean $\log_{10}$ HIV viral loads ($p = 0.02$), with more women having greater than 400 copies per milliliter (43% versus 27%; $p = 0.003$).

Subsequent analyses were conducted only among individuals receiving HAART. Almost three quarters ($n = 370$) of the sample was receiving HAART at the time of the interview and of those, 89% ($n = 330$) of the sample had a HIV viral load of less than 400 copies per milliliter. Similar proportions of the sample were receiving a PI-based therapy (48%) and NNRTI-based therapy (49%), 10 patients were receiving other HAART regimens. Only five respondents were receiving an unboosted PI-based therapy. Among those on HAART, women ($p < 0.05$), African American/other minorities ($p < 0.001$), between the ages of 18 and 34 years ($p = 0.01$), those with less than a high school degree/GED ($p < 0.001$), on PI-based therapy ($p = 0.032$), on at least their second line of therapy ($p < 0.05$), and with symptoms of depressive disorders ($p = 0.004$) were associated with viral load greater than 400 copies per milliliter.

Table 1. Overall Sample Characteristics ($n = 514$)

	Overall sample	
	n	%
Gender		
Male	348	67.7
Female	166	32.3
Race ($n = 494$)		
Caucasian	163	31.7
African American and other minorities	330	64.2
Age Category		
18–34 years	141	27.9
35–49 years	253	50.0
≥ 50 years	112	22.1
Employment status		
Employed	209	40.7
Unemployed/disability benefits	304	59.1
Education Level		
> High school	260	50.6
≤ High school diploma	254	49.4
Annual income ($n = 471$)		
> $10,000	231	44.9
< $10,000	239	46.5
Consider self homeless	39	7.6
Depressive disorders ($n = 503$)		
No disorders	283	55.1
MDD/ODD	220	42.8
Current HAART Prescription	370	72.0

MDD/ODD, major depressive disorder/other depressive disorders.

One quarter of the sample reported less than 95% medication adherence using the ACTG 4-day medication recall. Log_{10} HIV RNA level and self-reported adherence were negatively correlated (Pearson's $r = 0.52$, $p < 0.001$). African American/other minority participants more often reported less than 95% medication adherence (35% versus 15%; $p < 0.001$) and had viral loads greater than 400 copies per milliliter (15% versus 4%; $p = 0.001$) compared to Caucasian participants. Lower education attainment was associated with lower self-reported medication adherence as compared to those with higher levels of education completed (33% versus 23%; $p < 0.05$) and having a viral load greater than 400 copies per milliliter (17% versus 6%; $p = 0.001$). Employment status and income were not significantly associated with self-reported medication adherence or virologic suppression.

There were no differences in who was receiving PI-based or NNRTI-based therapies by gender, race, education attainment, depressive symptoms, or homelessness. Individuals with an annual income of less than $10,000 (58% versus 39%; $p < 0.001$) and who were unemployed (67% versus 53%; $p = 0.008$) more often were receiving PI-based HAART compared to individuals with an annual income greater than $10,000 and who were employed at least part-time, respectively. Self-reported medication adherence less than 95% occurred more frequently (34% versus 22%; $p = 0.01$) and unsuppressed viral loads occurred more often among individuals prescribed PI-based therapy (15% versus 7%; $p = 0.009$). Only one individual who was prescribed NNRTI-based therapy had unsuppressed viremia (>400 copies per milliliter).

About one third of the individuals with CD4 cell counts less than 350 cells/mm^3 ($n = 64$) were not currently prescribed HAART. Individuals not on HAART more often were female (46% versus 30%; $p = 0.03$), were African American/other ethnic minorities (42% versus 17%; $p = 0.003$), had less than a high school degree (43% versus 25%; $p = 0.014$), annual income of less than $10,000 (44% versus 26%; $p = 0.015$), and had MDD/ODD (41% versus 28%; $p = 0.05$) than their counterparts who had CD4 cell counts less than 350 cells/mm^3 cell counts and were on HAART. Additional details of these relationships are depicted in Table 2.

Table 3 shows details of the relationships between sociodemographic factors and clinic parameters. In unadjusted logistic regression models, individuals who were female, African American/other minorities, aged between 18 and 35 years, less than a high school degree/GED, had major or other depression disorder symptoms (MDD/ODD), were receiving PI-based therapy, and more than first regimen of HAART were more likely to have had a viral load greater than 400 copies per milliliter (each $p < 0.05$). After adjusting for gender, age, employment status, and type of therapy (PI- or NNRTI-based), individuals who were African American/other minorities had 2.85 greater odds of having unsuppressed viral loads than their Caucasian counterparts, those who completed less education had 2.32 greater odds of having unsuppressed viral loads as compared to those with higher levels of education, those who were receiving PI-based therapy had 1.40 greater odds to have unsuppressed viral loads than those on NNRTI-based therapy, and those who had expressed symptoms indicative of MDD/ODD had 2.53 greater odds of having unsuppressed viral loads unlike those who had minimal depressive symptoms.

Table 2. Comparisons among Individuals with CD4 Cell Counts Less than 350 cells/mm^3 ($n = 184$)

	Not Currently on HAART (n = *64*)		*Currently on HAART* (n = *120*)		
	n	%	n	%	p *Value*
Gender					
Male	37	29.6	88	70.4	0.032
Female	27	45.8	32	54.2	
Race					
African American and other minorities	56	40.6	82	59.4	0.004
Caucasian	8	17.4	38	82.6	
Age Category					
18–34 years	22	43.1	29	56.9	0.226
35–49 years	34	33.7	67	63.3	
≥ 50 years	8	25.0	24	75.0	
Employment status					
Employed	22	34.4	42	65.6	0.932
Unemployed	42	35.0	78	65.0	
Education					
≤ High school degree	43	42.6	58	57.4	0.014
> High school	21	25.3	62	74.7	
Income ($n = 168$)					
≤ $10,000	42	44.2	53	55.8	0.015
> $10,000	19	26.0	54	74.0	
Consider self homeless	9	52.9	8	47.1	0.25
Depressive disorder symptoms ($n = 180$)					
No disorders	25	27.2	67	72.8	0.052
Depressive disorder symptoms	36	40.9	52	59.1	
Viral load < 400 copies per milliliter	3	3.4	86	96.6	0.001

HAART, highly active antiretroviral therapy.

Discussion

This sample was a demographically and clinically representative sample of the overall population served at this urban HIV clinic, which is similar to the current HIV epidemiologic patterns of publicly funded clinics in the United States.[21] For the overwhelming majority of this clinic sample, virologic suppression was achieved. This treatment success was at least partly driven by self-reported adherence which was moderately correlated with virologic suppression in our sample. Individuals who were male, Caucasian, completed greater than a high school degree, and reported minimal depressive symptomatology were more likely to have achieved virologic suppression (<400 copies per milliliter). Individuals on first-line HAART were also more likely to have achieved viral suppression. Among individuals with CD4 cell counts less than 350 cells per milliliter, there were disparities by gender, race/ethnicity, education, income, and depressive disorders in regards to receipt of HAART.

It is evident from our analyses that patients at our clinic who continue to receive medical care and adhere to their treatment are more likely to successfully manage their HIV disease compared with patients who are not adherent to their prescribed treatment. While public infrastructures exist to create supportive services for provision of care, some individuals are unable to overcome the complexities of their lives in which HIV is just one part. The challenges that poverty presents continue to impact health outcomes. Many sociodemographic factors contribute to negative outcomes with HIV treatments, including gender, race, income, timing and type of therapy received.[5,23–26] Women and African Americans tend to have more challenges associated with engagement in HIV care, experience difficulty adhering to medication and higher rates of major depressive disorder, lower annual income, and serostatus disclosure challenges that tend to limit adherence.[14,26–36] The relationship between African American race and adherence-related virologic outcomes may be mediated by certain demographic factors such as low income, education attainment, and rates of employment that negatively affect medication adherence.[26,27] Additionally, reduced adherence may reflect concern for drug toxicity rather than loss of efficacy.[37] Prevalent depressive disorders also negatively impacted virologic suppression. While this finding is not novel, it illustrates the effect that comorbid conditions have on HIV disease, particularly psychiatric disorders, including substance use, depression, and anxiety disorders.[25,31–34] This finding highlights the importance of consistent screening of depressive symptoms and treatment of psychiatric disorders. Additionally, many individuals have limited experience in symptom expression, which may be additionally challenging in the context of their HIV infection. Without active screening, there is likely to be a relatively low level of symptom expression.[32,36–39]

Delays in HAART initiation are evident throughout populations with HIV and are partially attributable to late diagnosis and entry into medical care among women and racial/ethnic minorities; and thus more advanced disease progression.[5,14,33] Additionally, adherence to therapies tend to decline over time, higher rates of failure have been shown to occur with limited adherence to NNRTI-based therapy.[5,6]

Table 3. Sociodemographic Relationships with HIV Viral Load of Sample on HAART with and without Active Viremia ($n = 370$)

	Overall sample on HAART		*Viral load suppression* (n = *330*)		*Active viremia* (n = *40*)			*Unadjusted odds ratios (95%*	*Adjusted odds ratio (95%*
	n	%	n	%	n	%	p *value*	*confidence interval)*	*confidence interval)*
Gender									
Male	263	71.1	240	91.3	23	8.7	0.045	Ref	
Female	107	28.9	90	84.1	17	15.9		1.97 (1.01–3.86)	
Race									
Caucasian	134	36.2	129	96.3	5	3.7	0.001	Ref	Ref
African American and other minorities	236	63.8	201	85.2	35	14.8		4.50 (1.72–11.77)	2.85 (1.05–7.75)
Age Category									
18–34 years	82	22.2	66	80.5	16	19.5*	0.01		
35–49 years	192	51.9	174	90.7	18	9.4			
≥ 50 years	96	25.9	90	93.8	6	6.3*			
Employment status ($n = 369$)									
Employed	147	39.8	136	92.5	11	7.5	0.091	Ref	
Unemployed/disability benefits	222	60.2	193	86.9	29	13.0		1.85 (1.11–3.85)	
Education level									
> High school	203	54.9	191	94.1	12	5.9	0.001	Ref	Ref
≤ High school diploma	167	45.1	139	83.2	28	16.8		3.23 (1.58, 6.58)	2.32 (1.08–5.00)
Consider self homeless ($n = 39$)	20	23.3	15	75.0	5	25.0	0.159	2.42 (1.45, 8.46)	
Depressive disorders ($n = 364$)									
No disorders	210	57.7	196	93.3	14	6.6	0.002	Ref	Ref
MDD/ODD	154	42.3	130	83.8	26	16.7		2.81 (1.42, 5.59)	2.53 (1.24–5.18)
HAART type ($n = 360$)									
Ritonavir-boosted PI	178	48.1	151	84.8	27	15.2	0.009	Ref	Ref
NNRTI-based	182	49.2	170	93.4	12	6.6		2.53 (1.24, 5.18)	1.40(1.03–1.92)
Drug regimen ($n = 366$)									
1st line	236	64.5	217	91.9	19	8.1	0.017	Ref	
≥2nd line	130	35.5	109	83.8	21	16.2		2.20 (1.14, 4.27)	

[a]Identifies differences between youngest and oldest category.
HAART, highly active antiretroviral therapy; MDD/ODD, PI, protease inhibitor; NNRTI, non = nucleoside reverse transcriptase inhibitor

Overall, women in this study had higher HIV viral loads and received HAART less often than men. This finding may reflect a provider bias that women are less likely to achieve complete virologic suppression due to challenges with serostatus disclosure that impacts their adherence, and overall complex social situations. We previously reported similar findings that almost 50% of the women from our clinic population were not successfully suppressing their HIV viral load on HAART.[37] While there was no appreciable difference in CD4 cell counts by gender, these findings suggest further longitudinal examination of prescribing patterns for HAART and timing of initiation of HAART. When on HAART, women were more likely to be receiving PI-based rather than NNRTI-based HAART, yet those on NNRTI-based therapy had higher rates of adherence and virologic suppression. The gender differences that exist between PI-based and NNRTI-based therapies are most often due to concerns for potential pregnancy risk incumbent with efavirenz (NNRTI-based). In our study sample, there was equal distribution of NNRTI- and PI-based therapy. Additionally, PI-based therapy may be necessary for patients who have had difficulty adhering to medication, or are on second-line therapy or greater due to antiretroviral resistance.[45,46] Therefore, choices of the therapy type are often limited.

There were several limitations to our study. It was cross-sectional in nature, and cannot determine whether continued adherence to HAART is associated with sustained viral suppression and conducted in one publicly-funded Midwestern urban clinic and therefore our results may not be generalizable to other HIV patient populations. The inherent bias in self-reported data is continually a challenge when assessing risk behavior among individuals with HIV, yet short recall instruments were selected to limit this bias. Additionally, it has been documented that adherence rates decline after a 30-month follow-up period, the cross sectional nature of this study limits adding to this body of knowledge.[46]

Our study highlights that treatment success continues to be associated with sociodemographic factors including race, income, education level, and gender. Race tends to be a product of a complex network of factors that include socioeconomic status, education, and access to health care, which may limit continued engagement in care and medication, or overall social capital.[44] In our clinic, much of the patient population has a low annual income and struggles with other survival challenges that are not specifically related to HIV. Key features that have been highlighted in other research include missed clinic visits,[45] having children to care for in

the home (although not significant in this study),[29,47] and substance use disorders.[10] The treatment and care of individuals with HIV continue to be complicated by sociodemographic factors that are not easily modified, and findings suggest a need for further research regarding care provision is warranted.

This study examined factors that are associated with successful outcomes for individuals with HIV who are engaged in medical care. Race, education attainment, and type of HIV therapy play an essential role in determining HIV-related health outcomes. These findings signify the importance of individualized interventions to be delivered within HIV testing and systems of care that address the disparities in HIV care that exist, which have the potential to enhance engagement into medical care and medication adherence, as well as improve secondary prevention efforts.

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