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ORIGINAL PAPER

Medication Adherence and Sexual Risk Behavior Among HIV-Infected Adults: Implications for Transmission of Resistant Virus

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Abstract As more people are living long-term with HIV there are growing concerns about specific behaviors that can affect both personal and the public health. This study examined the relationship between antiretroviral therapy (ART) adherence and sexual risk behavior and their association with psychosocial and health factors among a diverse sample of 2,849 HIV-infected adults. Only 8.5% of the sample reported both non-adherence and sexual risk. Individuals were 46% more likely to report one of these risk outcomes when the other one was present and the presence of both outcomes was associated with an increased likelihood of having a detectable viral load. A simultaneous polytomous regression analysis revealed complex relationships among a range of psychosocial variables and the two primary behavioral risk outcomes. There is a need for targeted interventions and integration of mental health and substance use services into primary HIV care settings.

Keywords Prevention with positives · HIV transmission · Resistant virus · Adherence · Sexual risk

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Introduction

In the United States and other high resource countries, the widespread availability of antiretroviral therapy (ART) has decreased mortality due to HIV-related illness, leading to an increased prevalence of HIV in the population. Unfortunately, one consequence of widespread ART is increased viral resistance in people living long-term with HIV (Richman et al., 2004) and over time we have witnessed an increased frequency of drug resistant virus in newly infected individuals (Grant et al., 2002; Little et al., 2002). There is a growing public health concern about transmission risk behaviors among people with ART resistant HIV infection (Blower, Aschenbach, Gershengorn, & Kahn, 2001; Blower, Aschenbach, & Kahn, 2003; Chin-Hon et al., 2005; Kozal et al., 2004; Sethi et al., 2004).

A number of studies have asked whether people on ART are engaging in more sexual risk behavior than those not on treatment and a few studies have asked whether people with resistant virus are engaging in more risk than those with an optimal treatment response. A 2004 meta-analyses (Crepaz, Hart, & Marks, 2004) reviewed 25 studies examining the asso-

ciation between ART availability (i.e., being on treatment, having an undetectable viral load, beliefs about treatment/viral load and transmission risk) and sexual risk behavior among people living with HIV (PLH). They concluded that people on ART were no more or less likely to engage in unsafe sexual behavior than those not on ART even when they had an undetectable viral load. However, people's beliefs about ART and reduced viral load being associated with reduced transmission risk was related to a higher prevalence of unprotected sex. Recent studies that have compared people with detectable viremia and antiretroviral resistance to those without resistance and with an undetectable viral load have not seen significant differences in frequency of transmission risk behaviors between these two groups (Chin-Hong et al., 2005; Kozal et al., 2004).

Given that poor adherence can lead to the development of resistant virus (Bangsberg et al., 2004; Paterson et al., 2000; Wahl & Nowak, 2000) it is important to ask whether people with poor adherence to ART are the same people who are more likely to engage in sexual risk behavior with uninfected partners. A few cross-sectional studies have found a positive relationship between non-adherence and sexual risk behavior (Flaks, Burman, Gourley, Rietmeijer, & Cohn, 2003; Kalichman & Rompa, 2003; Wilson et al., 2002), though one study could not establish that relationship (Aloisi et al., 2002). While findings are somewhat mixed, perhaps due in part to differences in how ART adherence and transmission risk behaviors were operationalized, collectively there is evidence that poor adherence and sexual risk behaviors co-occur in a subset of PLH. Aloisi et al. (2002) found that among Italian participants categorized as non-adherent to HIV physician recommendations and medical appointments based on self-report ($n = 68$; 19% of their sample), 81% were sexually active in the previous 6 months, 40% reported no condom use during the last sexual intercourse at enrollment, and 27% reported no condom use during the last sexual intercourse at 12-month follow-up. In another study, Kalichman and Rompa (2003) found that among 112 participants (44% of the total sample) who reported missing a dose of medication in the past week, 32% engaged in any unprotected vaginal or anal sex, and 18% engaged in unprotected sex with an HIV negative or unknown serostatus partner. In a national study, Wilson et al. (2002) found that 47.3% of women who reported less than 95% adherence reported inconsistent condom use in the prior 6 months. More recently, Peretti-Watel et al. (2006) found that among non-adherent participants, 29% of heterosexual women reported at least one incident of unprotected vaginal or anal sex with an HIV negative or unknown serostatus partner, compared to 15% of homosexual men and 18% of heterosexual men, suggesting that individual factors may determine whether someone engages in both risks (non-adherence and risky sex).

Beyond simply asking whether there is a relationship between the two important behavioral outcomes of ART adherence and sexual risk behavior, it is important to know the specific background and psychosocial factors that determine whether someone engages in both risks versus only one risk, versus no risk in either domain. Knowing this would be useful for the development of targeted behavioral interventions for people living long-term with HIV. This study defined typologies of HIV-related behaviors (based on dual consideration of unsafe sex and poor adherence) and examined psychosocial factors that are associated with membership in the highest risk group.

The literature points to several psychosocial factors that are associated with unsafe sex and poor adherence as separate outcomes, rarely studied together within the same study sample. Depression, for example, has been associated with lower rates of adherence (Boarts, Sledjeski, Bogart, & Delahanty, 2006) as well as with unsafe sex among HIV-positive MSM on ART (Chin-Hong et al., 2005). High levels of perceived stress have also been associated with poorer adherence among HIV-positive adults (Bottanari, Roberts, Ciesla, & Hewitt, 2005), and with sexual risk behavior among a combined sample of HIV-positive and HIV-negative African-American men (Meyers, Javanbakht, Martinez, & Obediah, 2003). Anger has been associated with increased sexual risk behavior among HIV-negative gay men (Perkins, Leserman, Murphy, & Evans, 1993). Additionally, factors associated with burnout, such as safe sex fatigue and treatment fatigue, have been described as possible explanations for increases in unsafe sex and ART non-adherence (Cox, Beauchemin, & Allard, 2004; Nwoye, 2004; Tun, Celentano, Vlahov, & Strathdee, 2003).

While some psychosocial factors may contribute to risk, others may serve to protect against the co-occurrence of unsafe sex and non-adherence. For example, anxiety has been found to protect against non-adherence (Ingersoll, 2004), though this has not always been found (Tucker, Kanouse, Miu, Koegel, & Sullivan, 2003a). Social support may also protect against poor adherence (Stirratt et al., 2006) and sexual risk behavior (Kimberly & Serovich, 1999).

The present study was designed to examine more thoroughly the interaction between self-reported adherence and sexual risk behavior among a relatively large and diverse sample of adult men and women on ART. We wanted to know if there was a correlation between

these two important behavioral outcomes, as has been seen in several prior studies based on smaller samples. We then attempted to go further by trying to identify specific background and psychosocial factors that characterize people who present a significant public health risk, namely those who are both non-adherent and engaging in sexual transmission risk behaviors.

Methods

Participants

HIV-positive individuals in four cities (San Francisco, Los Angeles, New York City, and Milwaukee) were screened for recruitment into a clinical trial of an individually administered cognitive-behavioral intervention comprising modules to enhance coping with HIV, decrease sexual risk behaviors for the transmission of HIV, and improve ART adherence. Recruitment and screening of potential intervention study participants took place in medical clinics and community agencies serving HIV-positive clients. Brochures, posters, and staff descriptions about the study were also used to recruit participants. In addition, advertisements were placed in newspapers and magazines serving HIV-positive populations. Those who learned of the study by word of mouth were also eligible to be screened. Interested persons who provided verbal consent were briefly screened by project personnel to determine their self-reported HIV status as well as basic demographic and contact information and if eligible, were scheduled for a baseline interview. The baseline interviews, which simultaneously served to screen potential participants for trial entry, began in the summer of 2000 and were completed in the winter of 2002.

Participants were at least 18 years of age, provided written informed consent and written medical documentation of their HIV-positive serostatus (i.e., HIV test results; personal medication vial), and were not currently involved in another HIV behavioral intervention study. Additional exclusion criteria consisted of severe neuropsychological impairment or psychosis as assessed on a case-by-case basis by senior project personnel in collaboration with the clinical supervisor at the involved institution.

Measures

Demographics/Background

Detailed background and demographic data included items such as age, race/ethnicity, gender, educational level, employment status, income, homelessness, and conviction for a crime. Respondents also classified themselves as heterosexual/straight, homosexual/gay, bisexual, not sure, and other. For these analyses, participants were grouped as heterosexual versus bi- or homosexual, with ''not sure'' and ''other'' dropped from the analyses because they were few and findings would be difficult to interpret.

Medication Adherence, Viral Load and CD4

Recent self-reported ART medication adherence was assessed over a three-day period using an adherence survey developed for use by the AIDS Clinical Trial Group (Chesney et al., 2000). During ACASI, respondents indicated how many ART pills they had missed during each of the previous three days. Non-adherence was defined as missing any doses over the three-day period. Then using CAPI, participants were asked whether at last test their viral load was detectable or undetectable, and for their most recent CD4 test result. Data supports the reliability and validity of obtaining detectable versus undetectable viral load information and CD4 cell counts via self-report (Kalichman, Rompa, & Cage, 2000). Information also was obtained on the date at which the participant became aware of his/her HIV-positive status, and the number of months on his/her current ART regimen.

Adherence Self-efficacy

Adherence self-efficacy was evaluated using a 12-item Likert scale. The scale assesses patient confidence to carry out important health-related behaviors (asking physician questions, keeping appointments, adhering to medication). The α coefficient was .93.

Attitude Towards Medication

Attitude towards medication was assessed using 15 items scored on a 4-point Likert scale. The items address medical (e.g., ''My pills are difficult to swallow'') and behavioral (e.g., ''It is hard to fit my medications into my daily routine'') issues that could affect adherence (α = .99).

Sexual Risk Behavior

Sexual risk behavior was assessed using an ACASI adaptation of the Sexual Risk Behavior Assessment Schedule for Adults (SERBAS) (Meyer-Bahlburg, Ehrhardt, & Exner, 1991). Participants were asked about the number of times they engaged in sexual

behaviors (e.g., insertive or receptive oral, anal, or vaginal intercourse) with each partner over the past three months. They were asked to clarify their relationship to each partner as well as the partner's gender. For each sexual behavior exhibited, they were asked to report the number of times protection was used with each partner over the past three months. Convergent validity has been demonstrated in numerous studies in which theory-driven associations have been obtained between HIV sexual risk behaviors and other variables (e.g., Ehrhardt et al., 2002; Exner, Hoffman, Parikh, Leu, & Ehrhardt, 2002). Sample test–retest reliabilities for the SERBAS were: number of male partners, last three months (r = 1.00); number of lifetime male partners (r = .81); percent condom use for vaginal intercourse, last three months (r = .80). For this report, ''sexual risk'' was defined as unprotected vaginal or anal sex with a partner of unknown or HIV-negative serostatus.

HIV-Related Symptom Count

Adapted from a measure developed by the Adult AIDS Clinical Trials Unit Outcomes Committee (Justice et al., 2001), this 25-item scale was used to characterize current illness level. Using the CAPI, participants were asked whether they were experiencing a given symptom, and if so to indicate the degree to which it bothered them. Total HIV-related symptom count had an α coefficient of .85.

Alcohol and Substance Use

This measure was developed based on the findings of the initial qualitative phase of the present study, and was administered via ACASI to reduce response bias due to social desirability. Participants were asked to state the first and last time they used crack/cocaine, sedatives, tranquilizers, stimulants, barbiturates, analgesics, inhalants, marijuana, hallucinogens, steroids, methadone and heroin, as well as how often they used each substance in the past three months. A binary variable was created to capture recreational drug use, defined as any non-medical use of one or more of those substances in the prior three months.

Beck Depression Inventory

Depression was assessed with CAPI administration of the 21-item Beck Depression Inventory (BDI) (Beck, 1967). This measure assesses the severity of depression during the past week and each of its 21 items is scored from 0 (absent) to 3 (severe). Total scores can range from 0 to 63. The BDI is widely used as a depression rating scale and has been used in studies with HIV-positive patients to evaluate the severity of depressive symptoms (Weiser et al., 2006). The standardized Cronbach's α in this sample was .89.

State Trait Anxiety Scale

Anxiety was assessed with CAPI administration of the State Form of the State-Trait Anxiety Inventory (STAI) (Spielberger, Gorsuch, & Lushene, 1974). The STAI is a widely used self-report measure of state and trait anxiety, based on perceived feelings of tension and apprehension. The inventory has two forms (i.e., state and trait), each with 20 items rated on 4-point scales. This scale has been significantly correlated with standard measures of anxiety including the Institute for Personality and Ability Testing (IPAT) Anxiety Scale (r = .75–.77) and Taylor Manifest Anxiety Inventory (r = .79–.83) (Spielberger et al., 1974). As in a previous study with an HIV-infected population, we used only the state form, which is designed to assess feelings of anxiety at the time the subject completes the scale (in this sample, α = .90).

Anger-Burnout

Anger-Burnout was assessed via CAPI with a 16-item scale adapted from the anger and fatigue subscales of the Profile of Mood States (Chesney, Folkman, & Chambers, 1996). Participants are asked to rate on a 5-point Likert scale how often during the past month they have experienced feelings associated with anger and burnout (e.g., ''worn out'', ''resentful'', ''annoyed'', or ''fatigued''). An overall score is created by summing the ratings. In previous work with a large population of HIV-positive MSM the coefficient α was found to be .93 (Chesney et al., 1996), identical with that of this sample.

Perceived Stress Scale

Perceived stress was assessed with CAPI administration of the 10-item form of the Perceived Stress Scale (Cohen, Kamarck, & Mermelstein, 1983). Participants are asked to rate on a 5-point scale the frequency with which they have experienced stress-related thoughts and feelings during the past month (e.g., ''Felt that you were unable to control the important things in your life''; ''Found that you could not cope with all the things that you had to do''.) The validity of the 14-item scale has been established, and summing the ratings on this 10-item scale allows the assessment of perceived stress without any loss of psychometric quality over the

original 14-item scale (Cohen & Williamson, 1988; Pbert, Doerfler, and DeCosimo, 1992); in this sample, $\alpha = .86$.

Social Support

The Social Provisions Scale (SPS) was administered via CAPI and used to assess level, type, and perceived satisfaction with social supports from one's social network. This 24-item scale measures six dimensions of social support: guidance, reliable alliance, reassurance of worth, attachment, social integration, and opportunity for nurturance. The reliability and validity of the SPS is supported by a large number of studies (Cutrona, 1989), including past mental health intervention research with HIV-positive individuals (Kelly et al., 1993). An overall social support score was created by calculating a mean score across the six dimensions ($\alpha = .82$).

Procedures

The data reported in this paper are from the baseline interview that also served to determine eligibility for the randomized controlled trial mentioned above. All procedures and forms were reviewed and approved by the sites' Institutional Review Boards. Assessment interviews were conducted in private settings in research offices, community-based organizations, and clinics in the four cities. The interview was conducted over a period of two to four hours with regular breaks allowed to minimize respondent fatigue. Participants were compensated $50 for completing the baseline interview and those needing child care were eligible to receive an additional $10 to defray child care costs.

Procedures involved a combination of Audio Computer Assisted Self-Interviewing (ACASI) and Computer Assisted Personal Interviewing (CAPI) using Questionnaire Development System (QDS) version 2.0 by Nova Research Company. This approach has been proposed as an effective method of decreasing social desirability and thereby enhancing veracity of self-report of sensitive behaviors and attitudes (Gribble, Miller, & Rogers, 1999; Turner et al., 1998).

Interview Training

Interviewers were centrally trained with the use of a detailed assessment manual, practice with the computer programs, participation in an intensive 3-day training program, and review and certification of audiotaped mock interviews based on standardized criteria. All interviews were audiotaped and each tape labeled with the participant's study identification number, date of the interview, and the interviewer's identification number. Sites forwarded all tapes to a study site designated to perform quality review; a random sample of 20% of all tapes received from each site were reviewed. Feedback was provided on a monthly basis, but sites were notified immediately if raters identified severe violations of the assessment protocol by particular interviewers.

Data Analyses

Descriptive statistics and contingency tables are provided to orient the reader to the proportion of participants and mean values for background characteristics, risk behaviors, physical and mental health status, social support, and self-efficacy for adherence across the four sexual risk and adherence categories. The relationship between ART medication adherence and sexual risk behavior was first examined using a *t*-test to compare number of missed pills among those with no sexual risk versus sexual risk; logistic regression was additionally used to determine odds of non-adherence given sexual risk behavior. With this association established, a categorical variable was constructed to reflect the four possible combinations of ART adherence and sexual risk status: ART adherent without sexual risk, ART adherent with sexual risk, ART non-adherent without sexual risk, and ART non-adherent with sexual risk. To examine the relationship between the categorical sex by adherence variable and viral load, a linear trend test was performed.

To examine differences between those who were both non-adherent to ART and engaging in sexual transmission risk behavior and the other three ART adherence/sexual risk categories, multinomial regression was used. Multinomial regression is an extension of logistic regression for outcomes that have three or more outcome classes instead of a simple binary (yes/no) outcome. Instead of performing a series of logistic regression models, one for each of the ART adherence/sexual risk categories, the multinomial model provides a more comprehensive approach to estimating the parameters of interest by simultaneously considering the data from all groups. Each of the potential predictor variables was first examined individually, with the ART non-adherent and sexual risk group serving as the reference group. Prior to performing a multivariate analysis, intercorrelation tables were calculated to rule out possible multicollinearity. Variables were then selected that were independently associated with ART adherence and sexual risk status; these were

simultaneously entered into a multinomial regression analysis.

In selecting variables with potential explanatory value for understanding the intersection of non-adherence and sexual risk, we were guided by the empirical literature, within the constraints of the baseline assessment. Factors previously shown to be associated with non-adherence include heterosexual orientation and non-Latino ethnicity (Power et al., 2003), older age (Mellins, Kang, Leu, Havens, & Chesney, 2003), increased viral load (Paterson et al., 2000), lower levels of social support (Power et al., 2003), alcohol and drug use (Chesney et al., 2000; Mellins et al., 2003), and depression (Murphy et al., 2001; Paterson et al., 2000). Factors previously shown to be associated with unprotected sex among HIV-positive individuals include alcohol and recreational drug use (Kalichman, 1999; Lee, Galanter, Dermatis, & McDowell, 2003; Novotna et al., 1999), number of sexual partners (Lightfoot, Song, Rotheram-Borus, & Newman, 2005; Wyatt et al., 2002), self-identified homosexual orientation (Denning & Campsmith, 2005), female gender (in studies comparing heterosexual women and men) (Latkin, Forman-Hoffman, D'Souza, & Knowlton, 2004; Tucker, Burnam, Sherbourne, Kung, Gifford, 2003b), education (less than high school among MSM) (Denning & Campsmith, 2005), less social support (Reilly & Woo, 2004; Sherman & Kirton, 1999), viral load (Vanable, Ostrow, & McKirnan, 2003), health status (Sherman & Kirton, 1999), depressive symptoms and lower anxiety among MSM (Parsons, Halkitis, Wolitski, Gomez, & Seropositive Urban Men's Study Team, 2003). The variables examined in this study were sexual orientation, IDU, recreational drug use, number of male and female partners, number of AIDS-related symptoms, viral load, Anger-Burnout, BDI, STAI, perceived stress, social support, self-efficacy for adherence, and attitudes about ART.

Results

Participant Characteristics

Of the 3,819 individuals who underwent baseline assessment, the 2,849 (74.6%) currently on ART constitute the sample for the analyses that follow. Of these, 52% were MSM, 22% were heterosexual men, and 26% were women. The cohort was characterized by high levels of unemployment (70%) and participation in alcohol or drug treatment programs in the past three months (44%), with eight percent reporting IV drug use in the preceding year, and seven percent enrolled in a methadone maintenance program. Most (48%) had a highschool/GED or less education, 47% had ever been convicted of a crime, and 11% were homeless in the preceding year. The median age of participants was 41 years and the preponderance of participants were Black or African-American (48%), with 20% reporting Hispanic, 26% White, and 6% 'Other' ethnicity. Less than half (43%) reported currently being in a primary relationship. The median CD4 count at last medical evaluation was 380, and the median number of years since learning one's seropositive status was nine. Approximately half of the sample (47%) reported that their most recent viral load was undetectable. Most participants (84%) reported having seen a primary care provider within the past 3 months.

Adherence to ART and Sexual Risk Behavior

Slightly more than a third (35.2%) reporting missing medication in the past three days. In terms of transmission risk behaviors, 8.0% of those on ART reported IV drug use in the preceding year, and 20.0% engaged in sexual risk behavior, defined as unprotected vaginal and/or anal intercourse during the prior three months with a partner of discordant or unknown HIV serostatus.

There was a significant association between adherence to ART and sexual risk behavior, with those who engaged in sexual risk behavior reporting significantly more missed medication in the prior 3 days than those who practiced safer sex ($M = 3.66$ vs. $M = 2.78$, respectively; $t = (2747) = -2.82$, $P < .01$). Individuals who engaged in sexual risk behavior had 46% greater odds of missing medication (OR = 1.47; 95% confidence interval [CI] = 1.22, 1.77, $P < .01$). Those who were non-adherent to medication, regardless of sexual risk behavior, did not differ from each other in the number of missed pills (t (997) = –.57, n.s.). Slightly more than half of the sample was adherent to ART and did not engage in sexual risk behavior (53.2%). Approximately one fourth of the sample (26.7%) was non-adherent to ART but reported no sexual risk, 11.5% was ART adherent but reported sexual risk, and 8.5% reported both non-adherence to ART and sexual risk behavior.

Relationship between Medication Adherence/ Sexual Risk Behavior and HIV Viral Load

About half (47.3%) of the sample reported that their most recent viral load was undetectable. A linear trend test indicated that the distribution across groups was significantly linear, $F(1, 2747) = 19.93$, $P < .001$, with increments in proportions of those reporting detectable

viral load across categories: 49.2% of the ART adherent/without sexual risk group; 51.9% of the ART adherent/with sexual risk group; 58.5% of the non-adherent/without sexual risk group, and 59.1% of the non-adherent/with sexual risk group.

Associations between ART Adherence and Sexual Risk Behavior: Univariate Analyses

Results from univariate multinomial regression analyses that explored associations with ART adherence/

Table 1 Antiretroviral therapy (ART) and safer sex adherence: descriptive statistics and univariate multinomial regressions

	Descriptive statistics			Odds ratio from univariate multinomial regression[a]			
	ART and safer sex adherent	ART adherent but unsafe sex	ART Non-adherent but safer sex	ART & safer sex non-adherent	ART and safer sex adherent	ART adherent but unsafe sex	ART Non-adherent but safer sex
Gender							
Male	77.1%	67.6%	77.0%	66.0%	1.733***	1.075	1.729***
Female	22.9%	32.4%	23.0%	34.0%			
Race							
Black	48.4%	46.2%	57.8%	58.3%	.784	.621**	1.089
Latino	23.6%	20.1%	18.2%	15.3%	1.452*	1.030	1.307
White	28.0%	33.7%	24.0%	26.4%			
Education							
>High school	47.7%	51.7%	44.9%	50.2%	.904	1.061	.807
≤High school	52.3%	48.3%	55.1%	48.8%			
Sexual orientation							
Heterosexual	42.8%	47.7%	45.1%	43.6%	.966	1.177	1.063
Bi or homosexual	57.2%	52.3%	54.9%	56.4%			
If IDU past 12 months							
No	94.0%	92.0%	88.8%	90.5%	1.661**	1.221	.835
Yes	6.0%	8.0%	11.2%	9.5%			
If recreational drugs past 3 months							
No	50.2%	36.7%	38.7%	30.3%	2.323***	1.334	1.450**
Yes	49.8%	63.3%	61.3%	69.7%			
If HIV primary care past 3 months							
No	86.5%	85.9%	86.1%	83.8%	1.114	.933	1.008
Yes	13.5%	14.1%	13.9%	16.2%			
If detectable viral load							
No	50.8%	48.1%	41.5%	40.9%	1.491***	1.340*	1.025
Yes	49.2%	51.9%	58.5%	59.1%			
Total # of male & female partners	Mean rank 1280.61	Mean rank 1818.94	Mean rank 3561.83	Mean rank 1913.73	.960***	.999	.967***
Total # of AIDS-related symptoms	Mean 11.86	Mean 12.04	Mean 13.80	Mean 13.54	.947***	.953***	1.009
Most recent CD4 report	429.50	460.24	401.26	451.47	1.00	1.00	.999**
Beck depression inventory	11.79	11.59	14.64	14.61	.645***	.962***	1.000
State trait anxiety inventory	34.79	35.57	37.86	37.95	.974***	.981**	.999
Anger-burnout	24.26	25.17	28.28	29.20	.974***	.979***	.995
# Of years since learned HIV+	8.49	8.53	8.63	8.78	.979	.991	.986
Self-efficacy for adherence	93.93	92.16	78.02	77.15	1.034***	1.030***	1.001
Attitudes about medication	38.45	38.32	40.00	39.72	.959***	.955***	1.009
Social provisions	10.75	10.70	10.42	10.44	1.133***	1.107*	.993
Perceived stress	17.74	18.09	19.95	20.56	.942***	.949***	.987

[a] The reference category is: ART & safer sex non-adherent

* $P < .10$; ** $P < .05$; *** $P < .01$

sexual risk status are presented in Table 1. The group that reported both ART non-adherence and sexual risk behavior served as the reference group, since this is the group of greatest public health concern.

As can be seen in Table 1, no variables, except for viral load (as reported above) successfully distinguished the non-adherent with sexual risk group from all three other risk groups. However, some differences were found between individual subgroups.

ART Non-adherent/Sexual Risk Group versus no Sexual Risk Groups

Compared to those who reported no sexual risk (with or without ART adherence), the reference group was more likely to be female, report recent recreational drug use, and report more sex partners.

ART Non-adherent/Sexual Risk Group versus ART Adherent Groups

Compared to those who reported ART adherence (with or without sexual risk), the reference group was more likely to report a detectable viral load, more AIDS-related symptoms, more depression, anxiety, and anger burnout, and lower adherence self-efficacy, but more positive attitudes towards medication, less social support, and more perceived stress.

Multivariate Predictors of ART Adherence and Sexual Risk Group Status

To investigate whether the selected variables could successfully discriminate between the four groups, we conducted simultaneous polytomous regression. Overall, the model was unsuccessful at discriminating the reference group from the other three groups. Comparing the ART non-adherent with sexual risk group against all other participants, examining the same set of predictor variables described above, the model correctly classified only 1.3% of this reference group. Table 2 details the parameters and parameter estimates of a model predicting three types of ART adherence/sexual risk status, again with the non-adherent with sexual risk category serving as the reference group. The sample size for this analysis was 2,022 participants with complete data across the variables of interest. The model was able to correctly classify 89% of the ART

Table 2 Antiretroviral therapy (ART) and safer sex adherence: simultaneous polytomous regression

	Adherent to ART and safer sex[a]		Adherent to ART but unsafe sex[a]		Non-adherent to ART but safer sex[a]	
	Odds ratio	95% CI	Odds ratio	95% CI	Odds ratio	95% CI
Gender						
Male	2.248***	1.61–3.14	1.069	.72–1.59	2.112***	1.49–3.00
Female	–	–	–	–	–	–
Ethnicity						
Black	.706*	.49–1.03	.569**	.37–.89	1.012	.68–1.50
Latino	1.251	.78–2.00	.971	.56–1.68	1.161	.71–1.91
White	–	–	–	–	–	–
If IDU						
No	1.544	.91–2.63	1.451	.76–2.78	.809	.48–1.37
Yes	–	–	–	–	–	–
If recreational drugs						
No	2.012***	1.45–2.80	1.166	.79–1.73	1.522**	1.08–2.15
Yes	–	–	–	–	–	–
If detectable load						
No	1.141	.84–1.55	1.078	.75–1.55	1.056	.77–1.45
Yes	–	–	–	–	–	–
# Male & female partners	.961***	.95–.98	.995	.99–1.00	.958***	.94–.98
# Of AIDS-related symptoms	.995	.96–1.03	.993	.96–1.03	1.024	.99–1.06
Beck depression inventory	1.004	.98–1.03	.982	.95–1.01	.998	.97–1.02
State-trait anxiety inventory	1.004	.99–1.02	1.009	.99–1.03	1.008	.99–1.03
Anger burnout	.992	.98–1.01	.996	.98–1.02	.997	.98–1.01
Self-efficacy for adherence	1.032***	1.02–1.04	1.026***	1.02–1.04	1.002	.99–1.01
Attitudes about medication	.980	.95–1.01	.978	.95–1.01	1.007	.98–1.04
Social support provisions	.985	.86–1.08	.946	.83–1.08	1.021	.91–1.15
Perceived stress	.984	.95–1.02	.988	.95–1.03	.983	.95–1.02

[a] The reference category is: ART & safer sex non-adherent; significant results are in bold

* $P < .10$; ** $P < .05$; *** $P < .01$

adherent/no sexual risk group, 35% of the ART non-adherent/no sexual risk group, but only 2% of the ART adherent/with sexual risk group, and 1.3% of the ART non-adherent/with sexual risk group.

ART Non-adherent/Sexual Risk Group versus no Sexual Risk Groups

Compared to those who reported no sexual risk (with or without ART adherence), the reference group was more likely to be female, report recent recreational drug use and more sexual partners.

ART Non-adherent/Sexual Risk Group versus ART Adherent Groups

Compared to those who reported ART adherence (with or without sexual risk), the reference group was more likely to report Black ethnicity, IV drug use in the past year and lower adherence self-efficacy.

Discussion

In terms of the public health concern about potential transmission of resistant HIV, it was reassuring to find that only a relatively small percent of the total sample (8.5%) reported both non-adherence to ART and sexual transmission risk behaviors, although there was a relationship between these two behavioral outcomes as was found in prior research with smaller study samples (Flaks et al., 2003; Kalichman & Rompa, 2003; Wilson et al., 2002). In our larger and more diverse sample, people who reported non-adherence to ART were almost one and a half times more likely to report sex behavior that carried substantial risk for HIV transmission. This relatively small percentage of the larger sample presents concerns for risk to personal health as well as the public health, since people in this category are presumably at elevated risk for developing resistant virus and transmitting that virus to uninfected partners.

The fact that we could not easily distinguish the group of people that were both non-adherent and engaging in sexual risk behavior from the other categories, based on the demographic and psychosocial factors measured in this study, is challenging to the public health and HIV prevention fields, since this group of public health concern is not readily identifiable. It is interesting that different sets of factors were associated with sexual risk behavior versus adherence behavior. Certain background factors (i.e., being female) and recent substance use were more strongly associated with sexual risk behavior. Whereas, at least at the univariate level, psychological distress and stress, self-efficacy, attitudes towards treatment, and social support were more strongly associated with adherence to ART. Yet, the fact that people who engaged in sexual risk behaviors were more likely to be non-adherent to ART suggests that this subset of individuals presenting concerns for the public health have multiple psychosocial risk factors in their lives, most of which are amenable to change.

While not the primary focus of this paper, the linear relationship between viral load and membership in four categories of risk based on adherence and sexual risk behavior is interesting and worthy of further study. While one would certainly expect there to be a relationship between viral load and adherence, with poor adherence contributing to the development of viral resistance and detectable viral load, the relationship between viral load and sexual risk behavior was less expected and more unclear.

The fact that membership in the sexual risk categories was associated with an increased likelihood of having a detectable viral load, above and beyond the association with non-adherence, is intriguing. While no causal relationship can be ascertained from this cross-sectional study, it is possible that sexual risk behavior contributes to poorer health (less controlled virus) by exposing the person to pathogens that challenge the immune system. Relatedly, there is an interesting and important study that found an association between higher rates of insertive intercourse and higher seminal viral load among HIV-positive men, and the authors speculated that this may be a consequence of asymptomatic or subclinical urethritis (Kalichman et al., 2001, 2002). Further, if the causal direction of the association between viral load and sexual risk behavior were in the opposite direction, that is if knowledge of viral load (detectable versus undetectable) contributed to sexual risk behavior as has been noted in studies of treatment optimism (Kelly, Hoffman, Rompa, & Gray, 1998; Ostrow et al., 2002; Remien, Halkitis, O'leary, Wolitski, & Gomez, 2005) one would expect the direction of association to be opposite to that which was found. That is, knowledge of an undetectable load might lead to an increase in unprotected sex due to reduced risk perception for HIV transmission, not the other way around. Thus, it may be important for prevention among HIV-positive people to consider the potential for negative health outcomes that may be associated with unprotected sex, even when it does not involve the risk of HIV transmission to partners.

It is important to note that all of our study findings are limited by the cross-sectional nature of the data.

Longitudinal designs are needed to, identify cause–effect relationships between psychosocial or contextual factors and the likelihood of transmission-risk sex, particularly in the context of non-adherence to ART medications. Also this study did not assess the presence or absence of resistant virus and it must be noted that poor adherence does not always lead to the development of resistant virus and several other biological and behavioral factors can contribute to viral resistance. Nevertheless, the association between non-adherence and likelihood of the development of a resistant virus is a well-established phenomenon. Another important limitation involves the self-reported nature of medication adherence and viral load. While it is well known that people tend to report higher levels of adherence than their true behavior, it has been shown that self-report measurement of adherence can be robust and is associated with other adherence measures as well as HIV viral load (Simoni et al., 2006). Similarly, self-reported viral load can have poor reliability, but has been shown to be most reliable and valid when dichotomized as detectable versus undetectable, as was done in our study (Kalichman et al., 2000). Finally, this was a convenience sample and not population based, however, the sampling strategy allowed us to recruit a large and diverse sample very similar to the national profile of PLH. Our cohort closely mirrors current demographics of the epidemic (CDC, 2005). In comparison to the HIV Cost and Services Utilization Study that sampled a multi-city, diverse population of HIV-positive adults (Bing et al., 2001), our study included more members of ethnic minority groups and more members of low SES and may thus more closely approximate the HIV-infected population in the US (CDC, 2004, 2005).

Overall, the findings from this study support the need for ongoing integration of prevention into primary HIV care and treatment settings. In particular, attention must be paid to the mental health needs of PLH and AIDS. Alleviating stress and distress, treating substance abuse, and enhancing social support are likely to contribute to improvements in medication adherence and decreased sexual risk behaviors. Such approaches could be part of services offered in primary care settings to both optimize health outcomes and prevent further transmission. As noted by Morin et al. (2004) prevention counseling is not routine in most primary care clinical settings, representing missed opportunities for ongoing HIV prevention. While most PLH are not engaging in transmission risk behaviors, the subset of people with the aforementioned conditions present unique challenges to HIV and STD prevention, and may require specialized and innovative behavioral interventions. Targeting this population for prevention can contribute to a reduction in the continued spread of HIV to uninfected partners as well as reduce potential negative health outcomes for infected individuals.

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