A Multi-Site Study of Social Cognitive Factors Related to Adherence Among Youth Living With HIV in the New Era of Antiretroviral Medication

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Abstract

Objective The goal of the current study was to determine how a set of social cognitive factors predict antiretroviral therapy (ART) medication adherence in youth living with HIV in an era of newer highly active ART medications using a conceptual model. **Methods** Behaviorally infected youth living with HIV ages 13–24 ($N = 822$) from 14 sites within the Adolescent Medicine Trials Unit (AMTU) were included in the study. Structural equation modeling was used to explore predictors of ART medication adherence. **Results** Results found that motivational readiness for ART was related to higher ART medication adherence, which was associated with lower viral load. Higher social support and higher self-efficacy had an indirect relationship with higher adherence through increased motivational readiness. Fewer psychological symptoms were associated with higher social support and higher self-efficacy. Lower substance use was directly associated with lower adherence. **Conclusions** The results provide insight into factors that may be related to adherence in youth living with HIV. Findings suggest focusing on motivational readiness to increase adherence. Improving the patients' ART self-efficacy and strengthening their social support networks during treatment can increase motivational readiness for ART treatment. Furthermore, programs may be more effective with the inclusion of risk reduction components especially those related to substance use.

Key words: adherence; health behavior; HIV/AIDS.

Introduction

Advances in treatment have transformed HIV from a terminal illness to one that is potentially chronic and manageable (Hoy-Ellis & Fredriksen-Goldsen, 2007; Shi et al., 2010). However, this shift requires that patients are knowledgeable of treatment options and adhere to recommended medication regimens. Proper adherence to antiretroviral therapy (ART) medications is associated with viral suppression. Viral suppression is when a patient's viral load or amount of HIV virus

in the patient's blood is undetectable by laboratory tests (Kobin & Sheth, 2011). Greater viral suppression is associated with improved health outcomes for patients (Benator et al., 2015). Viral suppression is also associated with decreased transmission to sexual partners when engaging in risky sexual behavior (Cohen et al., 2016; Gray et al., 2000). It has also been found to be associated with lower transmission rates within a community when community viral load decreases (Das et al., 2010). Furthermore, over the

past decade, the newer formulations of ART have brought a new era of ART medication with lower toxicity levels that allow viral suppression to occur with adherence levels as low as 80% compared with near perfect levels required for earlier formulations (Kobin & Sheth, 2011; Viswanathan et al., 2015). While adherence is still critical for the effectiveness of ART medication, the aforementioned changes may have altered the barriers to medication adherence. Pragmatic reasons for not adhering to ART treatment have traditionally included number of pills or difficulty of taking medication (Chandwani et al., 2012). These types of issues may decrease over time with the improvement of ART medication, so it is important that we look at the psychosocial factors that hinder adherence.

Unfortunately, there are health disparities across demographic groups in rates of medication adherence. High-risk groups such as adolescents and young adults have been found to report poorer adherence rates compared with people of other ages (Hadland et al., 2012). Rates of HIV infection are growing fastest among youth of age 13–24 accounting for one-fifth of new cases, and as of 2013, there are an estimated 60,900 youth living with HIV (Centers for Disease Control and Prevention [CDC], 2017); yet, these youth are most vulnerable to barriers of sufficient care. In 2012, youth with HIV had the lowest rates of viral suppression of any age group (CDC, 2017). During adolescence and young adulthood, there are many co-occurring physical, cognitive, and social developmental changes. Because of these changes, there are increased opportunities for poor decision-making resulting in risky health behaviors (Steinberg, 2005). Research indicates that youth living with HIV report poorer medication adherence than people in other age groups (Kim, Gerver, Fidler, & Ward, 2014; Mullen et al., 2002; Reisner et al., 2009). Commonly cited reasons for nonadherence include forgetting, being too busy, and difficult medication routines (Chandwani et al., 2012; MacDonell, Naar-King, Huszti, & Belzer, 2013). Therefore, the combination of major life changes and greater risk-taking behavior can make managing a chronic health condition a much greater charge for youth.

Much research has focused on identifying factors that hinder ART medication adherence in people living with HIV (Reisner et al., 2009). Among youth living with HIV, poorer psychological functioning such as high anxiety and depression, greater substance use, HIV stigma, disclosure, and poor peer relations have been associated with lower adherence (Kuhns et al., 2016; MacDonell, Jacques-Tiura, Naar, & Isabella Fernandez, 2016; Rao et al., 2012). Youth are particularly sensitive to the effect of contextual issues such as stigma, disclosure, and peer relations; therefore, they should be considered when examining adherence

behavior. Understanding these factors allows an interventionist to identify those most likely to be at risk for poor ART medication adherence such as those with substance use problems or emotional distress.

Health models have been developed to account for factors correlated with behavior change. The Transtheoretical Model (TTM) (Prochaska & Velicer, 1997) suggests an individual's motivational readiness to change or the probability they will adopt a health behavior such as medication adherence is a precursor to actual behavior but may be impacted by other factors. The stages of change component of the model have been criticized because of inconsistent empirical research (Sutton, 2001; West, 2005). The current study focused on a continuous conceptualization of motivational readiness and how it impacts behavior (Migneault, Adams, & Read, 2005). A core aspect of TTM borrows from Bandura's (1977) self-efficacy theory, which cites perceptions of one's self-efficacy to adopt a health behavior and avoid temptation to engage in problem behavior as a major component of health behavior maintenance. Among a sample of minority youth living with HIV, self-efficacy has been shown to be related to adherence (MacDonell et al., 2016). In fact, self-efficacy is prominent in many behavioral change models (Rogers, 1975; Rosenstock, Strecher, & Becker, 1988). For the patient to follow through with an action, they need to feel that they will be successful in adopting the health behavior and likewise not engage in the problem behavior. Other factors related to motivational readiness to change include "processes of change" (Prochaska & Velicer, 1997). These processes of change explain why the change occurs, which may help guide intervention programs. The process of change that is a focus of this study is helping relationships, which has great implications for interventions. For example, the support can come in the form of things like counselor calls, a buddy system, or anything that would help aid the patient and support them during treatment either by lending emotional support or instrumental support (Prochaska & Velicer, 1997). For instance having greater social support can help lessen the burden of ART medication treatment (DiMatteo, 2004) as well as help young patients keep clinic appointments (Dietz et al., 2010).

While many factors are known to influence adherence, health behavior models such as TTM lack the inclusion of intrapersonal factors like psychological health and substance use, which have been identified as factors related to adherence (Rao et al., 2012). It is important to understand theory-related constructs in the presence of other potential variables. Previous research has investigated these constructs (i.e., social support, self-efficacy, and substance use) related to ART medication adherence individually or in pairs.

Figure 1. Hypothesized model of medication adherence and viral load.

Note. ASSIST = Alcohol, Smoking, and Substance Involvement Screening Test; BSI = Brief Symptom Inventory measuring psychological functioning; CRAFFT = Substance use questionnaire; GSI = Global Severity Index.

Few studies (MacDonell et al., 2016; Rao et al., 2012) have examined the complicated relationships among these variables. In a group of at-risk youth using path analysis, researchers did not find that motivational readiness was a predictor of adherence. Consequently, we examined several risk and protective factors together using more advanced statistical methodology, structural equation modeling (SEM), which takes into account measurement errors by including several observed variables that represent each latent construct.

Building on the results of prior research, we constructed our initial hypothesized model (Figure 1). In this model, we hypothesize that self-efficacy, a core construct of TTM, and social support, a process of change, mediate the effect of psychological health and substance use on motivational readiness to change. In addition, psychological health and substance are hypothesized to have a direct negative effect on adherence. Self-efficacy and social support will be related to motivational readiness to change and adherence. The study objectives are (1) to examine associations of intrapersonal factors, psychological health (i.e., depression, anxiety, and somatization), and substance use with self-efficacy and social support; (2) to examine associations of social support and self-efficacy with adherence; and (3) to examine the extent to which self-efficacy and social support mediate associations between psychological health/substance use and motivational readiness to change and adherence.

Methods

The data were collected through the Adolescent Medicine Trials Unit (AMTU). The purpose of the AMTU was to provide a network throughout the United States to carry out research examining adolescents and young adults infected with HIV and at risk of HIV exposure to better understand issues related to treatment and prevention and to ultimately intervene. The current study is from the Adolescent Trials Network (ATN) 125 protocol, a noninterventional study aimed at understanding youth in clinical care and their use of ART treatment. The current analysis was designed to investigate the relationship between the study outcome of adherence and study covariates.

Sample

Participants were recruited from 14 adolescent medicine clinics throughout the United States from February 2015 to February 2016. The adolescents were approached during one of their scheduled clinic visits. Those eligible to participate were either male or female, between 13 and 24 years of age ($N = 924$), behaviorally infected with HIV, currently receiving medical care from one of the participating sites with no restriction on when they entered care, understand spoken or written English, and have medical records that were accessible during the length of the study (see Table I for sample characteristics). Those that had not been prescribed medication to treat their HIV were

Table I. Cohort Characteristics (N=924)

Age % (n)	
13–15	0.3% (3)
16–17	4.1% (33)
18–19	13.0% (107)
20–21	27.7% (227)
22–24	54.8% (451)
Gender at birth (male) % (n)	81.9% (673)
Race % (n)	
Black/African American	74.3% (611)
Caucasian/White	10.7% (88)
Asian/Pacific Islander	0.5% (4)
Native American/Alaskan Native	0.5% (4)
Multiracial	8.6% (71)
Other or did not identify race	5.4% (44)
Hispanic % (n)	19.2% (158)
Education % (n)	
Less than high school	20.9% (172)
High school or GED	40.9% (336)
More than high school	37.4% (308)
None, no formal schooling	0.6% (5)
Do not know/refuse to answer	0.1% (1)
Employed % (n)	56.8% (467)
Income (annual) % (n)	
0 < \$600	22.4% (207)
\$600–\$5,999	29.9% (276)
\$6,000–\$35,999	31.9% (295)
>\$36,000	1.9% (17)
Refuse to answer/do not know	13.9% (129)
Living situation (current) % (n)	
Own house/apartment	30.0% (247)
Parents' house/apartment	42.3% (348)
Other family member(s) house/apartment	9.7% (80)
Non-family member's house/apartment	9.5% (78)
Other	10.1% (67)
Refuse to answer	0.2% (2)
Ever been in jail/prison? % (n)	38.7% (318)
Motivational readiness % (n)	
I am ready to go to medical appointments	81.6% (671)
I am ready to go to take medications	80.0% (685)
Self-efficacy M (SD)	4.7 (0.4)
Social support M (SD)	4.2 (0.8)
BSI general symptom index at clinic level % (n)	39.7% (326)
BSI somatization at clinic level % (n)	35.8% (290)
BSI depression at clinic level % (n)	45.1% (368)
BSI anxiety at clinic level % (n)	33.2% (263)
CRAFFT M (SD)	2.3 (1.3)
ASSIST M (SD)	8.4 (5.8)
Medication adherence >80%	62.8% (516)
Viral load copies/ml (SD) log10 transformed	2.7 (1.5)

Note. ASSIST = Alcohol, Smoking, and Substance Involvement Screening Test; BSI= Brief Symptom Inventory measuring psychological functioning; CRAFFT = Substance use questionnaire; GED = General Equivalency Diploma.

removed from the analyses for a final sample size of N = 822.

Procedure

Eligible youth were invited to participate in the study after they were given an explanation of the study and consent was obtained. The participants were asked to complete an audio computer-assisted self-interview (ACASI) that assessed youth on measures including

those related to adherence and psychosocial measures. Viral load results were obtained through medical records extraction. At the time of entry into the study, viral load results collected in the past 6 months were recorded. If viral load was not collected at that time, the most recent viral load result that was collected closest to the ACASI date was used. Participants were provided a small incentive appropriate to their level of time and effort given during the session. The time between the ACASI and viral load could range from 0 to 6 months.

Study protocol was approved by the institutional review board of the coordinating center site as well as the institutional review boards for all data collection sites.

Measures

Viral Load

Research staff abstracted biomedical and visit appointment data from the participants' medical records. Data abstracted included all viral load results in the past 6 months.

Adherence

Youth reported whether they were currently taking medication to treat their HIV. If not, they were asked if they were ever prescribed medication. If they were never prescribed medication for their HIV, they removed from the analyses. The youth were asked, "How many times during the day has your doctor told you to take a dose of medicine (pills or other medicines) to treat your HIV?" They were then asked, "Thinking about the last 7 days, about how many times did you miss taking a dose of pills?" Adherence was calculated by subtracting self-reported number of doses missed in the past 7 days from the total number of doses prescribed per week divided by the total number of doses prescribed per week (see [equation 1](#)). Dose is defined as a quantity of pills prescribed by the patient's doctor to be taken at a particular time of the day.

$$\text{Medication adherence} = \frac{7 \times \text{number of doses prescribed by doctor} - \text{number of times missed dose in 7 days}}{7 \times \text{number of doses taken per day}} \quad (1)$$

Demographics

Demographic items to describe sample characteristics included sex assigned at birth, race, education, employment, age, and living situation.

Psychosocial Factors

Motivational Readiness. As the TTM states, in order for behavior modification to take place motivational readiness to change must be present. This is the probability that one will adopt a given behavior. Motivational

readiness was assessed using Rollnick's Readiness Ruler (Stott, Rollnick, Rees, & Pill, 1995). Participants were asked to rate how ready they are to take HIV medications as prescribed (1 = not ready to 10 = ready to change or already changed). They were also asked to rate how ready they were to keep their doctors' appointments using the same 10-point Likert scale.

Social Support. Social support should be related to motivational readiness as it should serve as a process of change as suggested by the TTM. Six items assessed whether the participant believed that there were people in their life that were supportive about: keeping medical appointments, taking HIV medication, using condoms, telling their partner about their HIV status, avoiding drug use, and avoiding alcohol use. The scale was created by ATN-affiliated investigators to assess social support for issues related to HIV treatment and prevention. This measure was used by MacDonell et al. (2010) and was chosen to represent social support because it is specific to HIV and likely to be more predictive than general social support (Naar-King et al., 2006). Responses were assessed using a five-point Likert scale from "strongly disagree" to "strongly agree" ($\alpha = .86$). The six individual items were used as the observed variables for the social support latent construct.

Self-Efficacy. There were six items that assessed the participants' self-efficacy to adhere to their medication regimen and doctors' appointments. The measure was chosen because as the TTM suggests self-efficacy consists of both confidence to adopt a health behavior and the ability to avoid temptation of the problem behavior (Prochaska & Velicer, 1997). This scale has two subscales, confidence and temptation. The confidence subscale consisted of four items that assessed how confident they felt they could: "keep doctor and other health care appointments," "do better with keeping doctor and other health care appointments," "take the right amounts of medicine at the right times," and "do better with taking the right amounts of medicine at the right times." Two items assessed how confident they were that they could: "keep doctor and other health care appointments even if they were very tempted not to" and "take the right amounts of medicine at the right times even if they were very tempted not to." These two items created the temptation subscale. Responses were on a five-point Likert scale that ranged from "very sure I cannot" to "very sure I can." The items for self-efficacy specific to adherence were created based on Bandura's (1977) self-efficacy theory and pilot work used to assess self-efficacy in relation to adherence in Naar-King et al. (2006). The measure showed good internal

consistency in Naar-King et al. (2006) as did the current study ($\alpha = .83$).

Psychological Health. Psychological health is often associated with adherence. Therefore, we used the Brief Symptom Inventory (BSI-18) to assess psychological health (Derogatis & Melisaratos, 1983). The BSI-18 contains three dimensions, anxiety, somatization, and depression. Together these subscales make up a total scale also referred to as the global severity index (GSI). The BSI-18 has shown to be highly correlated with the total BSI making it a practical substitute for the larger scale (Andreu et al., 2008). By including multiple subscales in the psychological health latent construct, we can determine if there are certain subscales that better represent the concept of psychological health in relation to adherence. The BSI rates how much the participant feels distressed by a number of issues (e.g., thoughts of suicide and lack of appetite) based on a five-point Likert scale ("not at all" to "extremely").

Substance Use. Like psychological health, substance use was included in the model as a covariate. Two measures formed the latent construct of substance use. The Alcohol, Smoking, and Substance Involvement Screening Test (ASSIST) (World Health Organization, 2002) includes items related to how often they used of alcohol, marijuana, tobacco, cocaine, and opioids in the past 3 months. The CRAFFT is a six-item measure designed for use in clinical settings. The CRAFFT differs from the ASSIST, as it assesses the use of alcohol and/or drugs in specific contexts and the consequences related to their use rather than measuring the frequency (Knight, Sherritt, Shrier, Harris, & Chang, 2002). It is named after the items in the measure. Items include, "have you ever ridden in a car driven by someone who was high or had been using alcohol and drugs?", "Do you ever use alcohol or drugs to relax?", "Do you ever use alcohol or drugs while you are by yourself(alone)?", "Do you ever forget things you did while using alcohol or drugs?", "Do your family or friends ever tell you that you should cut down on your drinking or drug use?", and "Have you ever gotten into trouble while you were using alcohol or drugs?".

Data Analysis

Descriptive statistics were used to describe the sample. Pearson correlation analyses were conducted to examine the strength of associations between all indicator variables and medication adherence and viral load. Third, SEM analysis was conducted to examine the relationships among factors influencing adherence to HIV medication, and viral load using the Mplus 7. Model testing involved consideration of the hypothesized model (Figure 1) followed by modifications to

Figure 2. Revised structural model showing relationships among factors that influence HIV medication. Adherence and viral load (Model fit: CFI=0.985; TLI=0.981; RMSEA=0.030; SRMR=0.034; chi-square/df=1.73). R^2 value for adherence and viral load is 0.12 and 0.19, respectively.

Note. ASSIST= Alcohol, Smoking, and Substance Involvement Screening Test; BSI= Brief Symptom Inventory measuring psychological functioning; CFI = comparative fit index; CRAFT = Substance use questionnaire; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual; TLI = Tucker-Lewis Index.

^a $p < .05$; ^b $p < .01$; ^c $p < .001$.

improve parsimony. Modification indices along with theory were used to guide changes to the model. In the proposed model, we tested whether self-efficacy, motivational readiness, and social support had direct effects on medication adherence, which in turn predicted viral load. We also tested whether social support and self-efficacy predicted motivational readiness. Psychological health and substance use were included as covariates. It is expected that both variables will be associated with social support, self-efficacy, and adherence. We tested to see if social support and self-efficacy mediated the relationship between substance use or psychological health and adherence. Mediation effects were tested using the Sobel test, a commonly used method for testing the significance of the mediation effect (Sobel, 1982). The sample size for the current study is large, providing enough power to detect any mediated effects using the Sobel test. Standardized regression coefficients for all paths were estimated using maximum likelihood estimation. Missing data was handled using full information maximum likelihood. Goodness of model fit was assessed using standardized root mean square residual (SRMR), Bentler's comparative fit index (CFI) and Tucker-Lewis Index (TLI), and the root mean square

error of approximation (RMSEA). Good model fit is determined by an SRMR and RMSEA < 0.05 , and values of CFI and TLI > 0.95 (Byrne, 2013; Hu & Bentler, 1999). Standardized path coefficients were presented in Figure 2. Using the hypothesized model as a base, we removed nonsignificant paths from the model. Wald's test suggested that the removal of these nonsignificant paths did not increase the model chi-square.

Results

The sample consisted of 822 youth (see Table I for sample characteristics). A majority of youth were male at birth (81.9%), and the average age of the participants was 21.4 years ($SD = 2.2$), ranging from 13 to 24 years of age. Most participants were single (82.1%). Over half of the participants were employed; however, the sample was predominately low income (68.4% $< \$12,000$ yearly income). Participants were more likely to be enrolled in school (41.2%) and/or living with their parents (43.0%). The GSI was in the clinical range for 40.5% of the sample. Although some youth were prescribed medication to treat their HIV, 113 (13.8) reported not taking them at all, while 62.8% reported taking them at a rate of 80% or higher.

Bivariate Correlations Among Manifest Indicators, Medication Adherence, and Viral Load

The bivariate correlations for the manifest indicator variables, medication adherence, and viral load are shown in Table II. Most of the correlation coefficients are statistically significant at the $p < .05$ level. The indicator variables of same latent construct are strongly correlated with each other ($p < .001$).

Relationships Among Factors Influencing Adherence to HIV Medication and Viral Load

An initial hypothetical model was developed based on the TTM and a synthesis of the empirical literature (Figure 1). The model posits that social support, self-efficacy, and motivational readiness have direct positive effects on medication adherence, which in turn affect viral load. Social support, self-efficacy, and motivational readiness are influenced by psychological health and substance use. In addition, social support and self-efficacy predict motivational readiness.

The initial model includes 12 paths among five latent constructs and two manifest outcomes (i.e., adherence and viral load). Estimation of this model revealed a significant chi-square statistic and unacceptable CFI, TLI, and RMSEA values (model fit: CFI = 0.916; TLI = 0.890; RMSEA = 0.074; SRMR = 0.047; chi-square/ df = 6.11), indicating that the fit of the model to the data could be substantially improved. Several path coefficients were found not statistically significant. We eliminated the paths from substance use to social support and self-efficacy and the paths from social support and self-efficacy to adherence. We attempted to further improve the model's fit by adding three paths (e.g., social support $\rightarrow$ self-efficacy, substance use $\rightarrow$ adherence, and BSI $\rightarrow$ viral load) into the model. Adding these paths was consistent with previous bivariate correlation analysis that these variables were significantly correlated. The overall fit of this revised model was excellent (see Figure 2) and was retained as the final model. In modifying the initial model, we eliminated several nonsignificant paths and an indicator variable for BSI ("GSI"), as the standardized factor loading of the variable was slightly >1 , and residual variance was negative. The overall fit of the revised model was good. The chi-square/ df ratio was 1.73, the RMSEA was 0.034, the SRMR = 0.036, the CFI was 0.985, and the TLI was 0.981.

The revised structural model demonstrated relationships among factors and their direct and indirect effect on medication adherence and viral load (Figure 2). There were one latent exogenous variable (BSI), four latent endogenous (i.e., substance use, social support, self-efficacy, and motivational readiness) and two manifest endogenous variables (e.g., adherence and viral load) in the model. In the final model, higher motivational readiness and lower substance use

predicted adherence to HIV medication, which in turn predicted low levels of viral load. Higher self-efficacy and social support predicted higher motivational readiness, which in turn predicted adherence; higher social support also predicted higher self-efficacy. Psychological health predicted high levels of viral load. In addition, psychological health was associated with lower social support, lower self-efficacy, and higher levels of substance use. The analysis revealed an R^2 value of 0.12 for adherence and 0.19 for viral load, respectively.

The Sobel test of mediation effects indicated that motivational readiness mediated the relationship between self-efficacy and adherence ($z = 5.53$, $p < .001$) and the relationship between social support and adherence ($z = 3.15$, $p < .001$). In addition, the Sobel tests suggested that adherence mediated the relationship between motivational readiness and viral load ($z = -6.73$, $p < .001$).

Discussion

This study used SEM to explore adherence in the new era of ART medication in a multisite sample of adolescents and young adults. Among all study youth, one in four were not taking ART medications. Of those taking ART medications, 62.8% of youth reported taking their ART medications at an adherence rate of 80% or higher during a 1-week period. Past research finds similar rates of self-reported adherence among adolescent and young adult samples (12–24 years) (Kim et al., 2014). The meta-analysis of 50 eligible articles measured ART medication adherence using an objective measure of adherence if available; if not available, self-report data were used. Although some current ART medications require less stringent adherence rates than previous regimens, these findings underscore the importance of focusing intervention efforts on younger age groups to help improve adherence rates for more youth.

With recently collected data, we were able to determine psychosocial factors that play an important role in self-reported medication adherence among youth using newer generation of ART medications, where medication adherence is not expected to be at near perfect rates like it has in the past (Viswanathan et al., 2015). Higher psychological symptoms related to psychological health such as depression, anxiety, and somatization are associated with both lower social support and lower self-efficacy and associated with higher substance use and higher viral load. Substance use was negatively related to ART adherence. Higher social support was related to both increased motivational readiness and increased self-efficacy. Self-efficacy had a strong positive effect on motivational readiness. Higher levels of motivational readiness

Table II. Correlation Coefficients Among Factors Influencing HIV Medication Adherence and Viral Load

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
BSI																		
1. Anxiety	1																	
2. Depression	0.80***	1																
3. GSI	0.94***	0.91***	1															
4. Somatization	0.75***	0.62***	0.85***	1														
Social support																		
5. Avoiding alcohol use	-0.12***	-0.10**	-0.12***	-0.10**	1													
6. Avoiding drug use	-0.08*	-0.08*	-0.10**	-0.11**	0.73***	1												
7. Keeping medical appointments	-0.12***	-0.14***	-0.14***	-0.11**	0.37***	0.44***	1											
8. Taking HIV medication	-0.12***	-0.13***	-0.14***	-0.10**	0.39***	0.46***	0.69***	1										
9. Telling your partner HIV status	-0.14***	-0.17***	-0.17***	-0.13***	0.44***	0.44***	0.52***	0.58***	1									
10. Using condoms	-0.11**	-0.07*	-0.12***	-0.12***	0.44***	0.47***	0.45***	0.49***	0.45***	1								
Substance use																		
11. CRAFFT	0.30***	0.32***	0.31***	0.21***	-0.14***	-0.12***	-0.03	-0.02	-0.04	-0.03	1							
12. ASSIST	0.23***	0.24***	0.24***	0.18***	-0.17***	-0.15***	-0.03	-0.01	0.01	-0.04	0.58***	1						
Motivational Readiness																		
13. Get to medical appointments	-0.07*	-0.06	-0.09*	-0.07*	0.12***	0.10**	0.13***	0.10**	0.12***	0.12***	-0.01	-0.03	1					
14. Take medication as prescribed	-0.04	-0.03	-0.05	-0.05	0.13***	0.16***	0.12***	0.17***	0.15***	0.15***	0.00	-0.01	0.32***	1				
Self-efficacy																		
15. Confidence	-0.14***	-0.17***	-0.16***	-0.14***	0.20***	0.19***	0.21***	0.18***	0.19***	0.15***	-0.09**	-0.08*	0.20***	0.26***	1			
16. Temptation	-0.14***	-0.16***	-0.16***	-0.15***	0.21***	0.21***	0.21***	0.21***	0.22***	0.16***	-0.10**	-0.08*	0.20***	0.28***	0.76***	1		
17. Adherence	-0.11**	-0.12***	-0.13***	-0.11**	0.05	0.06	0.06	0.10**	0.03	0.04	-0.10**	-0.13***	0.07*	0.25***	0.18***	0.16***	1	
18. Viral load	0.10***	0.07	0.10**	0.11**	0.02	0.01	0.01	-0.02	0.04	0.01	0.08*	0.16***	-0.01	-0.13***	-0.02	-0.04	-0.43***	1

Note. * $p < .05$; ** $p < .01$; *** $p < .001$. ASSIST = Alcohol, Smoking, and Substance Involvement Screening Test; BSI = Brief Symptom Inventory measuring psychological functioning; CRAFFT = Substance use questionnaire; GSI = global severity index.

were associated with greater adherence, and in turn, greater adherence was associated with decreased viral load levels.

Examining our first objective, we found that psychological health can impact viral load as well as variables related to motivational readiness such as perceived social support and self-efficacy. Contrary to our hypotheses, psychological health was not related to adherence in the structural equation model. We did find an association in our bivariate analyses, but this effect was insignificant in our overall SEM model. It is possible when combined in a model of other potential predictors, its association may be indirect through its association on self-efficacy and social support which in turn impact adherence through motivational readiness to change. Rao et al. (2012) found this association in a sample of predominantly White HIV-infected youth compared with our mostly Black sample. Furthermore, the findings of Reisner et al. (2009) were found using a meta-analysis of studies dating from 1999 to 2008, which may have cohort effects especially as medications advanced over time. Higher substance use had a negative direct association on adherence; however, it was not associated with the psychosocial protective factors, self-efficacy, and social support. It has been shown that among behaviorally infected youth, like our current sample, substance use is associated with adherence level (MacDonell et al., 2013). Furthermore, the correlation between substance use and psychological health provides evidence that they co-occur; however, the two still have different effects in the model. Psychological health had an indirect effect through an association with psychosocial factors and substance use, while substance use had an association on adherence directly. If there is a substance use problem, these substances may take priority over the prescribed ART medications.

A key finding of the current study was the effect of motivational readiness on adherence. This is consistent with findings of several past studies (Migneault et al., 2005; West, 2005). As TTM suggests, a person's motivational readiness to change is essential to the adoption of a health behavior, which is affected by their self-efficacy to use that health behavior. The findings of other studies (Brown, Littlewood, & Venable, 2013; MacDonell et al., 2016; Naar-King et al., 2006) highlighted the importance of self-efficacy. The current model did not find a direct relationship between self-efficacy and adherence, but we found an indirect association through motivational readiness. Self-perceptions of one's ability to take on medical treatment will determine whether they feel motivated to adopt these behaviors. Although patients may understand the consequence of nontreatment, they are less likely to be adherent if they do not have the confidence to successfully adhere to their

treatment routine (Brown et al., 2013). Social support also had an impact on motivational readiness but not on adherence directly. TTM (Prochaska & Velicer, 1997) suggests that helping relationships or strong social support can be beneficial by making adherence less burdensome and having someone from whom they can seek assistance (Dietz et al., 2010; DiMatteo, 2004). The current results suggest that this occurs by increasing motivational readiness. Similarly, social support also had a positive association with self-efficacy. A patient's self-perceptions such as one's motivational readiness or self-efficacy may benefit from knowing there is a support system to help them adopt a health behavior and then continue using the health behavior. Unfortunately, interventions often do not have the ability to intervene in one's social support system; however, those with lower support systems can be flagged as higher risk. Furthermore, they may be able to supplement their social support network through therapeutic means. These high-risk individuals can be approached differently by focusing on what we can alter such as motivational readiness by the use of motivational interviewing, as it helps to promote self-efficacy by emphasizing the patient's strengths and providing support systems within the program itself. This suggests interventions must not only increase the patients' treatment skills and knowledge but also increase their self-efficacy and more importantly their motivational readiness for treatment.

Study Limitations and Future Directions

This study has many strengths such as examining a current sample of behaviorally infected youth taking ART medications and identifying psychosocial factors related to adherence. The sample was collected at 14 clinics across the United States making the sample very diverse geographically. In addition, the current study used multiple observed variables in the structural equation model. Using this methodology helps to minimize measurement error, making findings more robust. There are also some limitations. The study used a clinic-based convenience sample and may not be representative of all youth living with HIV. Additionally, the sample was predominantly Black. As indicated by the differences between our findings and those of Rao et al. (2012), it is possible that samples with different racial compositions may exhibit different behavior; however, this has not been examined directly. Future work would benefit from extending the SEM analyses to look at multigroup comparisons to see if each sample's behavior matches that of the predicted model. Also, with the exception of viral load, all measures were retrospective self-report measures including adherence. Results, however, do show moderate correlation between adherence and viral load, which suggest validity of the findings. Using a

meta-analysis, Shi et al. (2010) did find moderate correlations between self-report questionnaires and medication event monitoring system (MEMS) measures of medication adherence, suggesting self-report measures could be used as estimates for adherence. Future research would benefit from objective measures of medication adherence such as pill counts and electronic monitoring; however, the use of such techniques can be costly especially studies such as the current one which included a large sample across numerous sites. However, investigating pill count techniques that are more accessible and converting it into a measurement norm that clinicians could use during HIV treatment. Other possible measures include looking at biomarkers to test for medication present in one's system through hair, nail, or blood samples. This also has drawbacks in terms of practical use; however, the refinement of such test can have great value for clinicians and researchers. It is also worth investing in "real time" methods such as Ecological Momentary Assessment data to help improve self-report accuracy of their behavior.

It should be noted that the final model accounted for relatively low proportions of variance in both adherence and viral load. The *R*-square is relatively small because there were only two significant paths to adherence (from substance use and motivational readiness to change) and two significant paths to viral load (from BSI and adherence). Social support and self-efficacy did not have a direct effect on adherence in our final model. Medication-taking behavior is complex and involves patient, physician, and process components. It is possible that some important variables might not be examined in our study. As the work of Steinberg (2008) suggests, adolescents and young adults may be more prone to faulty decision-making by way of an immature inhibitory system linked to areas of the prefrontal cortex. For instance, neurocognitive factors such as executive functioning were shown to have an effect on adherence (Meade, Conn, Skalski, & Safren, 2011). The inclusion of these variables in addition to the psychosocial factors examined in the current study could be important to our understanding of adherence. We searched the literature and found our *R*-square for outcomes in our study is similar to several studies on medication adherence (Naar-King et al., 2006; Rosenstock et al., 1988). Another limitation of the study is the variability of the time since diagnosis. This was not controlled for, and it may be possible that youth who have been aware of their HIV status for a longer amount of time might have adjusted to their treatment differently than someone who has been recently diagnosed.

Implications for Practice

Current findings suggest that adherence in the current era of ART medication is a complicated process that

involves many factors. The most critical factor was motivational readiness to change, as it had a direct association with adherence. Fortunately, there are ways to increase motivational readiness to change through self-efficacy and social support. Particularly, programs using motivational interviewing are likely to be successful by focusing on the individual's strengths and improving self-efficacy to help increase the motivation to change. Furthermore, substance use is also directly related to adherence. Therefore, programs targeting youth should focus on multiple risk behaviors such as substance use to make a more comprehensive program. Addressing the multiple psychosocial factors associated with ART medication adherence could potentially improve overall health-related behaviors having a much greater impact on health outcomes.

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