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Impact of Food, Housing, and Transportation Insecurity on ART Adherence: A Hierarchical Resources Approach

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Abstract

Antiretroviral therapy (ART) has transformed HIV into a manageable illness. However, high levels of adherence must be maintained. Lack of access to basic resources (food, transportation, housing) has been consistently associated with suboptimal ART adherence. Moving beyond such direct effects, this study takes a hierarchical resources approach in which the effects of access to basic resources on ART adherence are mediated through interpersonal resources (social support, care services) and personal resources (self-efficacy).

Participants were 915 HIV-positive men and women living in Atlanta, GA, recruited from community centers and infectious disease clinics. Participants answered baseline questionnaires, and provided prospective data on ART adherence.

Across a series of nested models, a consistent pattern emerged whereby lack of access to basic resources had indirect, negative effects on adherence, mediated through both lack of access to social support and services, and through lower treatment self-efficacy. There was also a significant direct effect of lack of access to transportation on adherence.

Lack of access to basic resources negatively impacts ART adherence. Effects for housing instability and food insecurity were fully mediated through social support, access to services, and self-efficacy, highlighting these as important targets for intervention. Targeting service supports could be especially beneficial due to the potential to both promote adherence and to link clients with other services to supplement food, housing, and transportation. Inability to access transportation had a direct negative effect on adherence, suggesting that free or reduced cost transportation could positively impact ART adherence among disadvantaged populations.

Keywords

HIV; adherence; poverty; social support; self-efficacy

Antiretroviral therapy (ART) has transformed HIV into a manageable chronic illness. To reap treatment benefits, however, a high level of adherence must be maintained (Bangsberg et al., 2001; Bangsberg, Kroetz, & Deeks, 2007). Multiple challenges associated with poverty can impede optimal adherence (Ortego et al., 2011), which is concerning given that HIV disproportionately affects this population (CDC, 2011; Pellowski, Kalichman, Mathews, & Adler, 2013). This study takes a hierarchical approach, considering ways in which failure to fulfill basic needs can interfere with ART adherence through both direct and indirect channels.

Maslow's (1943) classic theory of hierarchical needs can be conceptualized as a framework for predicting ART adherence (see figure 1), dependent on ability to access 1) basic resources (food, housing, and transportation), 2) interpersonal resources (social support and services), and 3) personal resources (sense of mastery or self-efficacy). Research consistently documents an association between the ability to satisfy basic needs and ART adherence. A hierarchical resources approach suggests that lack of access to basic resources reduces access to interpersonal and personal resources, creating further adherence challenges.

In a hierarchical resources framework, fulfilling basic needs is seen as a starting point for successful achievement of the higher-order goal of ART adherence. People living with HIV who experience food insecurity report numerous barriers to adherence, including competing costs, stronger medication side effects when hungry, and concerns about eating a balanced diet when taking medications (Weiser et al., 2010). Food insecurity is associated with poor ART adherence and biological indicators of poor health, including CD4 count and viral load (Kalichman et al., 2010; 2014; Weiser et al., 2014). Homelessness and unstable housing also decrease the odds of achieving optimal ART adherence (Milloy et al., 2012; Palepu, Milloy, Kerr, Zhang, & Wood, 2011). Using a composite variable comprised of food and housing insecurity, Surratt, O'Grady, Levi-Minzi, and Kurtz (2015) found a significant, negative relationship with ART adherence, however, others have found no relationship between unstable housing and adherence once food insecurity was accounted for (Kalichman et al., 2010). Finally, lack of access to transportation is associated with lower ART adherence (Sagrestano, Clay, Finerman, Gooch, & Rapino, 2014). Qualitative research suggests that some living with HIV must forgo food and other necessities or miss ART doses in order to pay transportation costs (Tuller et al., 2010).

Beyond access to basic resources, interpersonal resources, such as social support or access to care services, are related to ART adherence. Social support can have a positive impact on treatment adherence (Catz et al., 2000; DiMatteo, 2004; Langebeek et al., 2014; Luszczyńska et al., 2007; Simoni et al., 2006), yet people living in poverty often lack sufficient social support, suggesting that poverty reduces ability to satisfy interpersonal needs, exacerbating challenges associated with ART adherence. Food insecurity correlates with lack of social support (Interlenghi & Salles-Costa, 2014; Kalichman et al., 2010), and homelessness can negatively impact support networks (Eyrich, Pollio, & North, 2003; Letiecq, Anderson, & Koblinsky, 1996; Shier, Jones, & Graham, 2011). Service providers and linkage to care represent another important interpersonal resource for people living with HIV. Positive interactions between patient and provider promote adherence self-efficacy and

ART adherence (Johnson et al., 2006), and services such as case management have been associated with improved ART adherence and viral outcomes in disadvantaged populations (Kushel et al., 2006).

Accounting for basic and social needs facilitates the achievement of personal resources, such as self-efficacy. This again demonstrates cascading effects of poverty as an impediment to ART adherence, given that poverty is associated with reduced self-efficacy (Boardman & Robert, 2000; Gallo & Matthews, 2003). Self-efficacy is a key component of numerous theories of health behavior (e.g., the Health Belief Model, Rosenstock, Strecher, & Becker, 1994; Social Cognitive Theory, Bandura, 1977), and has been consistently shown to predict ART adherence (Catz, Kelly, Bogart, Benotsch, & McAuliffe, 2000; Langebeek et al., 2014) and health outcomes such as viral suppression (Ironson et al., 2005).

In the current study, we take a hierarchical resources approach to ART adherence. Our conceptual model specifies access to *basic resources* (housing, food, transportation), *interpersonal resources* (services, social support), and *personal resources* (self-efficacy) as predictors of ART adherence. We expected indirect effects of food insecurity, housing instability, and lack of access to transportation on ART adherence, such that inability to meet basic needs would impede access to interpersonal supports, and poor supports would adversely impact self-efficacy. We also explored direct effects of lack of access to basic resources on ART adherence.

Methods

Participants

HIV positive men and women living in Atlanta, GA were recruited using flyers/brochures placed in the waiting areas of 41 community and social service agencies (e.g., social support groups, substance use treatment, case management) and infectious disease clinics listed by the Southeast AIDS Training and Education Center (2014). Participants who saw these flyers/brochures or learned of the study by word of mouth contacted the research office. Participants were over 18 and provided documentation of HIV positive status. Study procedures were approved by the Institutional Review Board. Participants provided informed consent, and were paid \$145 for completing study procedures.

Measures

Data were collected using ACASI (Audio-Computer-Assisted Self Interview). Questions assessed access to housing, food, transportation, services, and social support, and self-efficacy. Demographic variables included gender, age, education, ethnicity, income, and employment status.

Housing instability—Access to housing over the previous four months was assessed with one question: “I worried about having a place to stay,” scored from 0, *never true*, to 2, *often*.

Food insecurity—Food insecurity over the previous four months comprised of three questions. The first two, “I worried whether my food would run out before I got money to buy more,” and “The food that I bought just didn’t last and I didn’t have money to get

more,” were scored from 0, *never true*, to 2, *often*. “Were you ever hungry, but didn’t eat, because you couldn’t afford enough food” was scored as 0, *no*, or 1, *yes*.

Transportation access—Access to transportation over the previous four months was assessed with two questions: “I was not able to get where I needed to go because I did not have transportation,” and “I could not get to a clinic or doctor because I did not have transportation.” Answers were scored from 0, *never true*, to 2, *often*.

Ability to access services—Access to services over the previous four months was assessed with three questions: “Which best describes your ability to access AIDS services?” scored from 1, *able*, to 3, *not able*, “Which best describes your experience with accessing AIDS services in Atlanta?” scored from 1, *fewer services than before*, to 3, *more services than before*, and “Compared to other people with HIV/AIDS in Atlanta that you know, how would you say you are doing in getting the services you need?” scored from 1, *better than most*, to 3, *worse than most*.

Social support—Social support was measured with 14-items assessing tangible and emotional support (Brock, Sarason, Sarason, & Pierce, 1996), scored from 1, *completely true*, to 4, *completely false*. Examples include “I lack a feeling of intimacy with another person,” and “If I were sick, I could easily find someone to help me with my daily chores.”

Self-efficacy—The 12-item HIV Treatment Adherence Self-Efficacy Scale (HIV-ASES; Johnson et al., 2007), plus two additional items added to address following doctor’s orders and keeping appointments, assessed self-efficacy. Items were scored from 0, *not at all certain*, to 10, *very certain*. Examples include “How certain are you that you can stick to your treatment schedule when you aren’t feeling well?” and “How certain are you that you can integrate your treatment into your daily routine?”

Adherence—Unannounced pill counts are reliable and valid in assessing medication adherence, and are designed to minimize any possibility of pill-dumping (Haberer et al., 2012; Kalichman et al., 2007; 2008; 2010). Following an office-based interview and training in the pill counting procedure, participants were called at three unscheduled times over 12 to 16 day intervals using study-provided cellphones. The first pill count determines the initial number of pills in possession. Subsequent pill counts are used to calculate adherence, defined as the ratio of pills counted relative to pills prescribed, accounting for number of pills dispensed. All participants provided at least two pill counts within a one month timeframe. Adherence was calculated as the mean across antiretroviral medications and across pill counts.

Data analysis strategy

Structural equation modeling (SEM) with bootstrapped standard errors was conducted using lavaan in R (Rosseel, 2012). Before testing the structural regression model, the measurement model was tested for adequate fit using confirmatory factor analysis (CFA). Scales with many items were parceled using the balancing approach to reduce noise and sampling variability (social support as four parcels, self-efficacy as three; Little, Rhemtulla, Gibson, &

Schoemann, 2013). Latent variables with only one indicator had residual variance constrained to zero and latent variables with two indicators had loadings constrained to be equal to ensure local model identification. Scale was set by constraining the first indicator loading to 1. Covariances were estimated between all latent constructs. Adequacy of model fit was reported using the Comparative Fit Index (CFI), Tucker Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA).

A series of nested models were tested using chi-square comparisons. In the first model, all hierarchical paths were estimated. Nonsignificant paths were then systematically trimmed. In all instances, variables were treated as groups (i.e. paths from interpersonal resources were removed simultaneously, and paths from basic resources were removed simultaneously).

Demographics were tested in univariate analyses for association with ART adherence – categorical variables were dummy coded. Age was recoded so that one-unit change represented one decade. Significant associations were included as covariates in the full structural regression model.

There are three primary reasons we have adherence as the final stage within this hierarchy. 1) Self-efficacy is a well-known precursor to ART adherence (Catz et al., 2000; Langebeek et al., 2014). Because self-efficacy is later in the hierarchy, ART adherence can be thought to come after. 2) The data used for this study is longitudinal, with baseline hierarchy variables preceding the measure of ART adherence. 3) ART adherence does not fit neatly within earlier stages of the hierarchy. Although one might argue that HIV-positive status represents a threat to basic safety needs, adherence does not provide immediate positive feedback. Rather beneficial effects are only seen in the long term, and people often experience adverse reactions to ART (e.g., nausea, fatigue; Ammassari et al., 2001).

Results

Participants were 656 men and 262 women ($N = 915$) with data on ART adherence.¹ The sample had a mean age of 46.07 ($SD = 9.68$; Men: $M = 45.64$, $SD = 9.98$; Women: $M = 47.15$, $SD = 8.82$). Men reported a mean of 12.85 years of education ($SD = 1.78$), and women reported a mean of 12.19 years ($SD = 1.94$). Mean adherence was 85.41 percent ($SD = 17.48$). Full demographics are reported in table 1. White ethnicity, $B = .06$, $t(912) = 2.26$, $p = .02$, and age, $B = .03$, $t(913) = 5.82$, $p < .01$ were significantly related to adherence.

Measurement model

The measurement model demonstrated close fit. Factor loadings and latent variances/covariances are displayed in tables 2 and 3. A diagram of the measurement model is displayed in figure 2. The chi-square for the CFA was significant, $\chi^2(100, N = 915) = 246.08$, $p < .001$, however, the CFI and TLI both demonstrated close fit, CFI = .98, TLI = .97, as did the RMSEA = .04 (.03, .05).

¹Missing data was negligible (less than 3 percent). Thus listwise deletion was used.

Structural regression model

A path diagram for key variables is displayed in figure 3. The first model, estimating all hierarchical paths, exhibited close fit, $\chi^2(120, N=915) = 286.60, p < .001$; CFI = .98; TLI = .97; RMSEA = .04 (.03, .05).

In Model 2, the nonsignificant paths from social support to adherence and service access to adherence were trimmed, leaving only indirect paths through self-efficacy. Model 2 did not fit significantly worse than Model 1, $\chi^2(2) = 1.92, p = .38$, and exhibited close fit, $\chi^2(122, N = 915) = 288.52, p < .001$; CFI = .98; TLI = .97; RMSEA = .04 (.03, .04). In Model 3, the nonsignificant paths from lack of access to housing, food, and transportation to self-efficacy were trimmed. Model 3 did not fit significantly worse than Model 2, $\chi^2(3) = 2.22, p = .53$, and exhibited close fit, $\chi^2(125, N = 915) = 290.74, p < .001$; CFI = .98; TLI = .97; RMSEA = .04 (.03, .04).

Across all models, there was a consistent pattern of indirect effects from lack of basic necessities mediated through interpersonal supports and self-efficacy, negatively impacting ART adherence. Lack of access to transportation was directly associated with lower ART adherence, Model 3 $c' = -.15, p < .01$. Positive effects of social support on adherence and negative effects of lack of access to services ART adherence were fully mediated through self-efficacy. Detailed regression results are reported in tables 4 and 5.

Discussion

This study found support for a hierarchical resources approach to ART adherence. Across a series of nested models, lack of basic resources (housing, food, transportation) negatively impacted adherence indirectly through lack of interpersonal resources (social support, services) and personal resources (self-efficacy). Lack of access to transportation had a significant, negative direct effect on medication adherence.

Effects of housing instability, food insecurity, and lack of access to transportation on ART adherence were mediated effects through access to interpersonal and personal resources. This pattern supports the idea of a hierarchical, multistage process in which inability to access basic resources impedes ability to access interpersonal supports and personal resources, ultimately interfering with ART adherence. If primacy of food and housing needs prevent people living with HIV from focusing on higher-order goals such as developing support structures and skills necessary for achieving optimal levels of adherence, providing access to basic resources might create a context in which interventions designed to increase supports and self-efficacy can function more effectively.

Of the basic resources considered, only lack of access to transportation had a direct, negative effect on ART adherence, suggesting that transportation represents a unique barrier to adherence. Without transportation, people are unable to access care or medications in order to comply with treatment, even if they intend to do so. Indeed, accessing patient advocate services is associated with living closer to healthcare facilities (Igumbor, Scheepers, Ebrahim, Jason, & Grimwood, 2011). Home-based care and medication delivery show promise in promoting adherence and viral load suppression in HIV-positive populations who

may lack access to transportation (Weidle et al., 2006), and providing a transportation stipend, along with text-messaging, facilitates prompt return to care and ART initiation following abnormal CD4 test results (Siedner et al., 2015). These studies did not, however, explicitly isolate and test the effects of transportation on treatment adherence. Future interventions should consider the unique effects of providing transportation to and from doctors and pharmacies. Access to transportation might also be considered as a moderator of intention to comply with treatment recommendations and actual treatment adherence.

Finally, it is important to note that lack of access to food, housing, and transportation often co-occur. Factors associated with poverty therefore place people at high risk for other barriers to adherence – those facing one obstacle are likely to face others, and these obstacles have cumulative effects on adherence.

A hierarchical approach to ART adherence highlights the importance of addressing basic needs as barriers to health, and suggests important components of intervention development. Interventions providing supplemental food show promise for increasing adherence (Cantrell et al., 2008), and providing housing has been associated with improved biological outcomes in people living with HIV (Buchanan, Kee, Sadowski, & Garcia, 2009). Providing transportation to and from appointments or medication delivery might further increase adherence among people living in poverty. Future research might also consider the role of HIV-related stigma, especially when considering links between interpersonal and personal resources. For example, stigma might undermine feelings of self-efficacy, while simultaneously reducing the likelihood of accessing social or service supports

Although it might seem prohibitive to consider the cost associated with providing basic resources to all people living in poverty in need of treatment for HIV, addressing these needs creates a foundation for interventions to successfully bolster supports and self-efficacy necessary to increase ART adherence. Comprehensive interventions addressing basic needs may even reduce healthcare spending. Cost-utility analysis has demonstrated that provision of HIV-related housing might reduce spending on emergency room visits and other healthcare costs (Holtgrave et al., 2013). Intervening at a later stage in the hierarchical model also shows promise, as providing services might promote adherence through treatment and care linkage, while simultaneously addressing interpersonal and basic needs. For example, case management has been associated with fewer unmet needs, and may help prevent a transition to unstable housing (Katz et al., 2001).

Results should be interpreted in light of study limitations. The measure of treatment self-efficacy was not specific to ART adherence, which may have attenuated the relationship between self-efficacy and adherence. Another limitation is the generalizability of the sample. The sample was one of convenience, recruited from a wide range of health services, and may not be representative of people living with HIV without linkage to care. Participants were also geographically restricted to a southeastern city in the United States, and may differ from those in less urban areas or outside of the United States. Finally, the measure of food insecurity was not comprehensive, which may have attenuated any direct relationships with adherence.

To reduce health disparities in HIV/AIDS care for people living in poverty, it is critical to improve ART adherence. This study found consistent support for a hierarchical resources approach, suggesting an ordered framework of barriers to optimal adherence. Conceptually, the results highlight the importance of providing basic resources to people living with HIV in an attempt to bolster other supports and promote optimal health. Targeted interventions designed to improve access to resources at multiple levels would also be beneficial.

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Figure 1.
Diagram of Maslow's hierarchy of needs as applied to ART adherence.

Figure 2.

Path diagram of full CFA. Squares represent indicators, circles represent latent variables, straight lines represent factor loadings and residuals, and curved lines represent variances and covariances. Fixed paths are denoted with a dashed line.

Figure 3. Path diagram representing full hierarchical resources model. Straight lines represent regression paths. Curved lines represent variances and covariances.

Table 1

Continuous comparisons were run as t-tests; means and standard deviations are reported. Categorical comparisons were run as chi-square analysis; total N and percentage are reported.

		Combined	Male	Female	p-value
Age		46.07 (9.68)	45.64 (9.98)	47.15 (8.82)	< .001
Education (years)		12.85 (1.78)	12.85 (1.78)	12.19 (1.94)	.03
Adherence		85.41 (17.48)	85.27 (17.53)	85.76 (17.38)	.70
Income	\$0-\$10,000	584 (64.0%)	392 (60.0%)	192 (74.1%)	< .001
	\$11,000-\$20,000	225 (24.7%)	174 (26.6%)	51 (19.7%)	
	\$21,000-\$30,000	74 (8.1%)	60 (9.2%)	14 (5.4%)	
	Over \$30,000	29 (3.2%)	27 (4.1%)	2 (.8%)	
Ethnicity	White	54 (5.9%)	37 (5.6%)	17 (6.6%)	.48
	African-American/Black	837 (91.5%)	598 (91.2%)	239 (92.3%)	
	Hispanic/Latino	11 (1.2%)	10 (1.5%)	1 (.4%)	
	Asian/Pacific Islander	1 (.1%)	1 (.2%)	0 (.0%)	
	Other	12 (1.3%)	10 (1.5%)	2 (.8%)	
Employment	Unemployed	240 (26.3%)	178 (27.2%)	62 (23.9%)	.21
	Working	131 (14.3%)	101 (15.4%)	30 (11.6%)	
	On Disability	509 (55.7%)	351 (53.6%)	158 (61.0%)	
	Student	17 (1.9%)	11 (1.7%)	6 (2.3%)	
	Other	17 (1.9%)	14 (2.1%)	3 (1.2%)	

Table 2

Factor loadings for final CFA model. Constrained loadings are indicated with a *. All loadings are statistically significant at $p < .001$

Construct	Indicator	Loading
Adherence	Adherence Pill Count	1.00*
Self-Efficacy	Parcel 1	1.00*
	Parcel 2	1.14
	Parcel 3	1.16
Social Support	Positive Parcel 1	1.00*
	Positive Parcel 2	.91
	Negative Parcel 1	1.04
	Negative Parcel 2	1.04
Service Access	Item 1	1.00*
	Item 2	-1.13
	Item 3	1.12
Food Access	Item 1	1.00*
	Item 2	.91
	Item 3	.47
Housing Access	Item 1	1.00*
Transportation Access	Item 1	1.00*
	Item 2	1.00*

Table 3

Variance/Covariance matrix for final CFA. Variances are on the diagonal, covariances are void the diagonal. All estimates are significant unless underlined.

	Food	Housing	Transp.	Services	Social Support	Self-Efficacy	Adherence
Food	.46						
Housing	.30	.57					
Transportation	.19	.20	.23				
Services	.09	.09	.07	.07			
Social Support	-.16	-.16	-.11	-.07	.26		
Self-Efficacy	-.23	-.22	-.18	-.14	.27	2.00	
Adherence	-.02	<u>-.01</u>	-.02	<u>-.00</u>	<u>.01</u>	.04	.03

Table 4

Standardized regression estimates across all models;

Regression		Model 1 β	Model 2 β	Model 3 β
~ Adherence	Age	.16**	.16**	.16**
	Ethnicity	.05*	.06*	.06*
	Self-Efficacy	.14**	.14**	.14**
	Access to Services	.08	--	--
	Social Support	.05	--	--
	Access to Housing	.08	.08 ⁺	.08 ⁺
	Access to Food	-.04	-.04	-.04
	Access to Transportation	-.16**	-.15**	-.15**
~ Self-Efficacy	Age	-.02	-.02	-.02
	Ethnicity	.07*	.07*	.07*
	Access to Services	-.22**	-.22**	-.24**
	Social Support	.26**	.26**	.27**
	Access to Housing	.05	.05	--
	Access to Food	-.02	-.02	--
	Access to Transportation	-.06	-.06	--
~ Access to Services	Age	-.01	-.01	-.01
	Ethnicity	.06	.06	.06
	Access to Housing	.19**	.19**	.18**
	Access to Food	.17**	.17**	.17**
	Access to Transportation	.30**	.30**	.31**
~ Social Support	Age	-.03	-.03	-.03
	Ethnicity	-.04	-.04	-.04
	Access to Housing	-.18**	-.18**	-.17**
	Access to Food	-.25**	-.25**	-.25**
	Access to Transportation	-.19**	-.20**	-.20**

⁺ $p < .10$,* $p < .05$,** $p < .01$.

Table 5

Standardized indirect effects predicting adherence across models;

Indirect Effects	Model 1	Model 2	Model 3
Housing → Services → Self-Efficacy	-.01 ⁺	-.01 ⁺	-.01 [*]
Housing → Social Support → Self-Efficacy	-.01 [*]	-.01 [*]	-.01 [*]
Food → Services → Self-Efficacy	-.01	-.01	-.01 ⁺
Food → Social Support → Self-Efficacy	-.01 [*]	-.01 [*]	-.01 [*]
Transportation → Services → Self-Efficacy	-.01	-.01	-.01 ⁺
Transportation → Social Support → Self-Efficacy	-.01 [*]	-.01 [*]	-.01 [*]
Services → Self-Efficacy	-.03 [*]	-.03 [*]	-.03 [*]
Social Support → Self-Efficacy	.04 ^{**}	.04 ^{**}	.04 ^{**}

⁺
 $p < .10$,^{*}
 $p < .05$,^{**}
 $p < .01$.