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Motivation as a Mechanism for Daily Experiences' Effects on HIV Medication Adherence

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Abstract

Medication adherence is a challenge for people living with HIV (PLWH), who may experience a gap between their intentions and everyday behaviors. We measured PLWH's ($n = 87$) daily experiences and tested a model to explain the intention-behavior gap. Participants completed baseline questionnaires, then used a smartphone-based survey and an electronic pill bottle to provide daily data for the next 10 weeks. These PLWH, with generally well-controlled HIV, were nevertheless adherent on only 73% of study days. Multilevel analyses were used to test predicted relationships between variables ($n = 58$). 4 of 5 theory-based daily measures predicted motivation for antiretroviral therapy (betas = 0.06–0.10), and motivation in turn predicted adherence. Consistent with our theory, control beliefs, mood, and social support had indirect effects on adherence. However, stress and coping did not. Daily experiences affect adherence, even in PLWH with well-controlled HIV. Providers should ask about everyday changes in motivation.

Keywords

adherence; antiretroviral therapy; ecological momentary assessment; HIV; motivation

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Imagine a patient, Mr. S., who is prescribed antiretroviral therapy (ART) for HIV. His health care provider, Dr. T., counsels Mr. S. that persons living with HIV (PLWH) must use medication almost perfectly—at least 95% of doses taken—to gain the desired benefits of ART (Bangsberg et al., 2006; Paterson, Swindells, & Mohr, 2000). Because Dr. T. also knows that ART adherence tends to be low even for newer medications (Langness, Cook, Gill, Boggs, & Netsanet, 2014), he asks Mr. S. to complete the Morisky adherence scale (Morisky, Green, & Levine, 1986) at his next clinic visit. Mr. S. indicates on the measure that he “always or almost always” takes his medication as prescribed, and that he missed no more than 2 doses per month. Both Mr. S. and Dr. T. are, therefore, surprised to learn that Mr. S.’s HIV viral load (VL) remains high. Before suggesting a change in medication regimen, Dr. T. asks for a consult from a pharmacist co-located in the HIV clinic, who recommends further evaluation of adherence using an electronic pill-bottle monitoring device. When that device is read 1 month later, both Dr. T. and Mr. S. are surprised to learn that Mr. S. was less adherent than he thought: 7 missed doses in the month, for an overall 75% adherence rate. Given that Mr. S. did not appear to have been deliberately deceiving Dr. T., what happened here?

Literature Review

Differences Between Retrospective and In-the-Moment Measures of Experience

As with most health behaviors, medication adherence actually occurs as a series of discrete events in patients’ day-to-day lives. Health care providers might view taking medication as the single most important activity of a patient’s day, but this is not the patient’s perspective (Koop, 1985). As is the case for most people, Mr. S. experienced his life as a series of discrete psychological events or *momentary states*. These affected his actions, and his behavior also occurred as a series of discrete momentary activities (Reis, 2012; Shiffman, Stone, & Hufford, 2008). Even behaviors that are usually habitual, such as medication adherence, can be affected by day-to-day variability in mood, motivation, or other factors that serve as either barriers or facilitators to adherence behavior (Cook, Schmiede, Starr, Carrington, & Bradley-Springer, 2017). Unfortunately, models of behavior that have been developed based on retrospective measures of patients’ experiences may not generalize to the prediction of moment-by-moment behavior (Riley et al., 2011) because aggregate retrospective questions (e.g., *On average, how adherent were you over the past week?* or *How did you feel on most days in the past week?*) tap into memory and language rather than into the immediacy of momentary events (Kahneman, 2011). This cognitive filtering of events (Schwartz, 2012) is what accounts for the discrepancy between Mr. S.’s actual medication-taking behavior in the moment, and his beliefs about his behavior as indicated on Dr. T.’s questionnaire. Mr. S. sees himself as an adherent person and, therefore, he unintentionally misremembers his actual behavior. In clinical practice about 20% of PLWH who are prescribed ART have levels of adherence too low to achieve treatment goals (Langness, et al., 2014; White House Office of National AIDS Policy, 2016), and we suggest that state-trait discrepancies between people’s beliefs and behaviors explain at least part of this gap.

Because of cognitive biases in memory and language, measures of the same construct from the same person with respect to the same period of time can nevertheless show substantial and clinically important differences when they are collected in real-time (Ptacek, Pierce, & Thompson, 2006). New mobile technologies facilitate the collection of intensive longitudinal data from frequent measures of patient experiences close to the times when they occur. This research strategy, known as ecological momentary assessment, is illustrated in the clinical example above where the pharmacist used technology to monitor adherence in real time. When using this approach, a shorter duration between experience and its evaluation means that self-report measures are less affected by post-hoc cognitive editing. Discrepancies between real-time and post-hoc data collection have also been found in studies of PLWH (Mustanski, 2007).

Differences between momentary behaviors and retrospective measures of behavior may explain the relative weakness of current adherence interventions. Programs to improve ART adherence have low-to-moderate effect sizes (Finitsis, Pellowski, & Johnson, 2014; Simoni, Amico, Pearson, & Malow, 2008; Van Camp, Van Rompaey, & Elseviers, 2013), a finding in line with a Cochrane review that reported small-to-moderate effects for all current interventions to improve medication adherence (Nieuwlaat et al., 2014). Despite its importance in ART, treatment adherence is a problem that resists solutions despite good intentions and sincere efforts by both patients and health care providers. Rather than focusing on the question, *Which patients are non-adherent?*, a study of momentary state data can address the potentially more clinically useful question, *Under what circumstances are patients non-adherent?* (Dunbar-Jacob & Mortimer-Stephens, 2001). This might, in turn, lead to a better understanding of the barriers and facilitators of adherence behavior that are amenable to in-the-moment change.

Theory Development to Predict In-the-Moment Behaviors

Our study was based on a momentary motivation model suggesting 6 variables that might affect adherence behavior (Figure 1; Cook, McElwain, & Bradley-Springer, 2010). Momentary state predictors in this model are *control beliefs* (feelings of control in one's everyday life), *momentary mood* (a positive-to-negative continuum of affective states), *stress* (in-the-moment experiences of acute or chronic stressors), *coping* (use of active and/or avoidant strategies to manage stress), and perceived *social support*. Additionally, the model proposes a mechanism, *motivation*, by which other momentary states affect behavior. The proximal role of motivation was proposed based on similar constructs – self-efficacy and intention – with the strongest direct relationships to behavior in models based on retrospective measures such as the theory of planned behavior (Ajzen, 2011) or the IMB model (Fisher, Fisher, Amico, & Harman, 2006).

Preliminary data suggest that components of this model do predict in-the-moment health behaviors, with control beliefs, mood, and motivation predicting adherence to HIV prevention recommendations (Cook, McElwain, & Bradley-Springer, 2016), and mood and motivation predicting ART adherence (Cook et al., 2017). However, a comprehensive test of the model has not yet been conducted, in particular looking at the indirect effects of daily experiences on adherence by way of motivation. Our analysis in this paper was designed to

take the next step in the process of theory development. Interventions to increase ART adherence might be improved by identifying a variable such as motivation that serves as a final common pathway through which other variables have their effects on adherence. If motivation is the central link in causal paths by which other momentary state variables affect adherence, then it would be an ideal target for in-the-moment interventions such as tailored text-messaging apps or social media messaging.

Our analysis was designed to test whether momentary motivation was, in fact, a mechanism by which other everyday experiences affected adherence, as posited in our original model (Cook et al., 2010). A direct relationship between motivation and adherence has previously been established in the dataset used for this study (Cook et al., 2017). A direct effect of mood on adherence was found, with no direct effects of the other 4 momentary state variables – control beliefs, stress, coping, or social support. In this analysis, which was part of our original research plan, we tested all 5 momentary state variables as individual predictors of motivation, and also tested whether motivation remained a significant independent predictor of adherence after controlling for these variables' effects. If both of these conditions are met, it suggests motivation is a pathway by which other momentary state variables affect adherence.

Methods

Participants

Participants in this secondary analysis were 87 PLWH recruited from an outpatient Ryan White Part B infectious disease clinic in Denver, CO. Participants were: (a) documented to have HIV infection and currently on ART based on medical records; (b) able to speak, read, and write English; (c) between ages 18 and 80 years; and (d) able to use a smartphone after initial training. PLWH were excluded if they had a severe enough level of current substance abuse, cognitive impairment, major psychiatric disorder, co-morbid medical disorder, or other condition, that, in the judgment of the referring clinician, would interfere with study participation. PLWH were recruited at the time of a regularly scheduled clinic visit with their usual HIV care provider, and were representative of the overall clinic population (Cook et al., 2017). The Colorado Multiple Institutional Review Board approved the study, and participants provided informed consent.

Participants' average age was $M = 40.0$ years ($SD = 8.84$, range: 21 to 59), and the sample was diverse in terms of race, ethnicity, and gender as shown in Figure 2. About half of participants (41/87) were men who had sex with men, 3 were women who had sex with women, and the remaining participants identified themselves as heterosexual. Participants' HIV was generally well-managed, with 91.1% having an undetectable VL (< 200 copies/mL) in the past 6 months and a median CD4 + T cell count of 494 cells/mm³ ($IQR = 677$). The average number of ART doses per day was 1.45, with slightly more than half of participants on a once-daily regimen. Participants' average level of education was 13.4 years ($SD = 2.3$), with 79/87 participants having at least a high school diploma. Most participants had multiple co-morbid conditions, including 54% with a co-morbid substance abuse diagnosis, and 25% with a serious and persistent mental illness. Fully 25% of participants were homeless or unstably housed, and another 9% were in supported housing. Most

participants had either Medicare/Medicaid (41%) or Ryan White program funding (38%). In general, these demographics suggest that participants were typical of the diverse, multi-problem population affected by the U.S. HIV epidemic.

Procedure

Study intake and follow-up—During an intake session at the clinic, each participant completed a packet of baseline self-report questionnaires (data not presented here). Participants then received a smartphone and a Medication Event Monitoring System (MEMS) device for daily survey data collection. After 10 weeks, they returned to the clinic for a follow-up meeting. Participants were paid \$25 USD after completing each of the 2 in-person sessions.

Daily surveys—During the intake session, the research assistant provided the participant with a smartphone (Samsung hardware and Android operating system) that was pre-loaded with Apptive® scheduling software. This software delivered a cue for the participant to take an online survey at a randomly selected time each day. Survey timing was not linked to medication dosing because of concern that the survey reminder would interfere with natural patterns of ART use. Participants completed the survey by clicking an Internet URL to a secure questionnaire hosted by SurveyMonkey®. During intake participants were instructed on use of the smartphone and practiced completing the daily survey once with the research assistant. Participants were allowed to keep their smartphones at the end of the study if they completed at least 1 month of surveys, but the study paid for service fees only during data collection.

Measures

Demographic and clinical data—Participants provided demographic information on their age, gender, sexual orientation, level of education, employment, race/ethnicity, housing or homelessness, and insurance or other access to care. Other data were extracted from medical records with authorization, including latest HIV VL, latest CD4+ T cell count, ART regimen, co-morbid medical conditions, mental health conditions, and substance use.

Daily smartphone surveys—All survey items were piloted in a prior daily-state study of PLWH (Cook et al., 2010), and used a 4-point response scale from the Diary of Ambulatory Behavioral States (DABS: Kamarck, 1998): 1 = *YES!!*, 2 = *yes??*, 3 = *no??*, or 4 = *NO!!*. Subscales measured control beliefs (4 DABS items, $\alpha = .84$), mood (3 DABS items, $\alpha = .93$), stress (6 items from the Daily Hassles Scale; Holm & Holroyd, 1992; $\alpha = .67$), coping (10 items from the Assessment of Daily Coping; Stone & Neale, 1984; $\alpha = .86$), and social support (2 DABS items, $\alpha = .95$). The proposed mechanism by which these variables affect adherence – motivation for ART – was measured on a scale adapted from Herzog and Blagg (2007), with items such as *having a plan to take medication*, *intending to take medication*, and *having the desire to take medication*. This scale has internal consistency of $\alpha = .79$ and good predictive validity (Herzog & Blagg, 2007). A prior analysis from the same dataset found significant relationships between the mood and motivation daily survey scales and subsequent ART medication adherence (Cook et al., 2017).

Behavioral adherence data—During the intake session participants also received a MEMS bottle with a plunger in the lid to electronically record each date and time that the pill bottle was opened. Participants were instructed to store their most frequently taken ART medication in the bottle and to open the bottle only when taking medication. They received a tip sheet with instructions and a telephone number to call the investigators with any questions. MEMS caps track bottle openings rather than actual use, but are considered a high-quality proxy measure of adherence (Chesney, 2006). The measure's reliability has been supported by a low rate of technical errors (Cook, Schmiede, McClean, Aagaard, & Kahook, 2011) and its validity by correlations between MEMS data and VL in HIV (Liu et al., 2001). We included a 6-week run-in phase to control for measurement reactivity (Cook et al., 2011); there was some reactivity but it did not affect results (Cook et al., 2017), so analyses with complete data are presented.

Analysis Plan

Data quality and completeness—Twenty participants were excluded from the original sample because they did not have both daily survey data and behavioral MEMS data; this was generally because they did not return the MEMS bottle after multiple outreach attempts. Another 9 participants who completed less than 10 daily surveys were removed from analyses due to concerns about the accuracy of multilevel estimates with few data points, resulting in a final sample of 58 PLWH with a mean of 47 surveys for each. This represented survey completion on 68% of possible days. Missing data were handled via maximum likelihood estimation in a multilevel modeling analysis that included all available data points. Because participation length varied, we included the number of participation weeks as a covariate in all analyses, consistent with our strategy in previously published analyses from the same dataset (Cook et al., 2017).

Relationships of momentary state predictors to motivation—As a first step in our test of the proposed theoretical model, we examined paths from each of the 5 momentary state variables to momentary motivation, all of which were measured as part of the daily survey. A relationship between momentary motivation and behaviorally measured adherence has already been shown in the current dataset ($OR = 1.55$; Cook et al., 2017). In the current analysis, we examined relationships between the other 5 daily survey variables and motivation in a multilevel modeling framework, to account for non-independence among multiple daily observations from the same participant as well as serial autocorrelation over time. All available daily observations were used, with missing data on any of the variables handled via maximum likelihood estimation. However, our analysis was limited to the 58 participants with behavioral adherence data, so that the sample would be the same as that used in the next stage of the analysis and in a previous publication, even though MEMS data were not used in this step.

Tests of motivation as a mechanism for effects on adherence—Tests of proposed causal pathways from one variable by way of another have traditionally included 3 steps (Baron & Kenny, 1986): (a) testing the predictor variable's effect on an outcome, such as control beliefs predicting adherence; (b) testing the predictor variable's effect on the proposed mechanism of effect on the outcome variable, such as control beliefs predicting

motivation; and (c) testing the proposed mechanism's effect on that outcome, in this case, motivation as a predictor of adherence, after adjusting for the predictor (control beliefs). In this example, an effect of control beliefs by way of motivation would be assumed if the relationship between control beliefs and adherence was nonsignificant in the third stage of the analysis, while motivation was significant. Because we expected each predictor variable's effect to be independent of the others, we tested a combined model with all potential predictors entered together. Two variables—stress and coping—were dropped at this stage of analysis because they had insufficient numbers of observations due to planned missing data (i.e., participants were only asked about these variables if they reported a stressor on the day of the survey). However, one of these variables had no significant effect on motivation in the first stage of the analysis, and we also looked at each variable in a separate model as a sensitivity analysis. Conclusions were unchanged regardless of which approach was used, so the simpler combined model is presented.

Power analysis—Power for within-person multilevel models depends on the number of observations, not the number of participants, after correction for the intra-class correlation of observations from the same person, which we conservatively estimated at .70 (Hox, 2002). With as few as 33 data points (consistent with data completeness in a pilot study; Cook et al., 2010) from as few as 62 participants, power was .80 at $\alpha = .05$ to detect moderate-sized within-person effects of $r > .39$ in multilevel models.

Results

Overall Adherence

Despite having generally well-controlled HIV, participants took their ART on only 73% of study days. MEMS are known to be a reactive measure of adherence behavior (Cook et al., 2011), which might have contributed to a higher average adherence of 81% during the first week of monitoring. As the reactive-measurement effect decreased over the first 4 weeks of the study, participants' average adherence declined to 73%. Their adherence remained stable at this relatively low level thereafter. This level of variability in daily adherence behavior suggested that they were at increased risk for negative treatment outcomes over time, even though 91% were virally suppressed (VL < 200 copies/mL) at the start of the study.

Momentary State Variables as Predictors of Motivation

Table 1 shows the relationship of each of the 5 theoretically relevant daily experience variables to motivation. Four of the 5 momentary state variables examined in daily surveys had significant effects on motivation, with stress being the exception. This was true even though a prior analysis found that only mood and motivation had direct effects on adherence (Cook et al., 2017). These findings were consistent with the notion of motivation as a final common pathway by which other momentary state variables have their effects on behavior. In this situation, variables that predicted changes in motivation could still have an indirect effect on the outcome based on motivation's more proximal relationship to adherence behavior.

Motivation as a Mechanism for Other Momentary State Effects on Adherence

In the second stage of analysis, we also found evidence that motivation was a mechanism by which other momentary state variables could affect adherence for 3 of the 5 predictors in our original model (Table 2). In the cases of control beliefs, mood, and social support, there was evidence that the momentary state variable predicted motivation, which in turn predicted adherence behavior. When all variables were entered into the model together, motivation remained a significant predictor of adherence. So did mood, which was not unexpected because mood was found to have direct effects on adherence in a previously published analysis of this dataset (Cook et al., 2017). Stress and coping were omitted from the combined model due to the much smaller number of data points on these variables. Stress did not predict motivation, as described above, so it could not have affected adherence by way of motivation. We verified the results for coping and all other predictors in a sensitivity analysis predicting adherence behavior from each variable individually with motivation and treatment duration as covariates. Conclusions from that analysis were the same as those for the combined model in Table 2.

Discussion

Our study was designed to test relationships predicted in a theoretical model of momentary state effects on ART adherence behavior, which may be different from the relationships observed when the same variables are measured using retrospective questionnaires. Participants' daily adherence to ART was less than optimal based on a behavioral measure, despite their generally well-controlled HIV. A key variable – motivation – has been identified in prior research using the same dataset to identify the best predictors of behaviorally-measured ART medication adherence from daily electronic survey questions. Our study further advances understanding of motivation's role in daily adherence behavior by testing it as a mechanism for other momentary state variables' effects on adherence.

In line with our predictions, 4 of the 5 other momentary state variables had significant effects on momentary motivation. This was consistent with the posited central role of motivation as a predictor of adherence behavior. It is noteworthy that only one of the 5 variables studied – momentary mood – had a direct effect on adherence in prior analyses (Cook et al., 2017). The other 3 variables that predicted motivation in this analysis did not predict adherence directly. This may be because these variables also have substantial error variance, such as day-to-day variations in perceived social support, coping, and feelings of control, that do not directly relate to adherence even though they do have an effect on motivational states.

Also in line with our predictions, 3 of the 5 momentary state variables had significant indirect effects on ART adherence behavior by way of motivation. One of these was mood, which has already been shown to have a direct effect on adherence; the current analysis adds to previous findings by demonstrating that at least part of this variable's effect on adherence occurred by increasing or decreasing motivation to take ART. This might be interpreted to mean that mood, at least in part, affects desire to take medication, rather than just being a distractor that affects memory or activity level. Similarly, an indirect effect of social support might mean that this variable also affects internal motivation rather than being simply an

external facilitator that assists in actual performance of the behavior. Additionally, control beliefs had an indirect effect on adherence as predicted by our theoretical model, even though there was no significant direct effect of control beliefs on adherence in prior analyses.

Contrary to our theory, neither stress nor coping had significant indirect effects on ART adherence even though coping was found to correlate significantly to motivation. This adds to prior findings that neither stress nor coping had a direct effect on adherence (Cook et al., 2017). One important caveat is that neither stress nor coping were measured as consistently as the other variables: In an effort to reduce participant burden, we asked an initial screening question about stress (*Did you have any stressful events today?*), and omitted the stress and coping subscales if participants answered *no*. Therefore, conclusions about stress and coping were based on substantially fewer data points and may have been less reliable. Because of this methodological limitation, stress and coping might still be examined in future studies of momentary state effects on behavior, with items about stressors and coping strategies asked at every data collection point.

Clinical Implications

Our findings about the effects of control beliefs, mood, and social support confirm that day-by-day motivation is an important mechanism by which everyday experiences can affect patients' ART adherence behavior. Clinicians should monitor patient motivation for ART, with the understanding that motivation goes up and down over the course of everyday life and has an important effect on successful use of ART. Further, clinicians should ask patients about their perceptions of control, moods, and experiences of social support, as these variables affect adherence indirectly (with mood having direct effects as well).

Our findings about stress and coping may be surprising to clinicians who experience the reality of patients saying that they did not take their medication and blaming their nonadherence on temporary stressors such as housing problems, legal challenges, or interpersonal conflicts. Indeed, such causal explanations for nonadherence are among the most frequent in our experience talking to patients about the use of ART— it is the rare patient who says, "I guess I just didn't want to take the pills very much!" Our analyses support patients' and clinicians' contentions that coping affects motivation to take medication, although stressors did not have a similar effect. Yet the lack of a significant direct or indirect connection to adherence for either variable suggests that perhaps stressful life experiences affect adherence behavior less than patients believe. In other words, a motivated enough patient will stay adherent regardless of variations in stress and coping and, for an unmotivated patient, reducing stressors alone is unlikely to help. Rather, a tendency to cite stressors may reflect a general tendency for some patients to externalize the causes of their behavior in order to avoid taking responsibility or blame. However, this counter-intuitive finding clearly requires replication, and further investigation is needed to help clinicians know how best to work with the patient who blames stress for lack of adherence.

Limitations and Directions for Future Research

Although this study had notable strengths, including a behavioral measure of adherence and a within-person longitudinal design, there were also limitations. Sample size was the greatest of these, with only 58 PLWH having sufficient adherence data for inclusion in the tests of motivation as a mechanism for momentary state variables effects on adherence. The sample yielded more than 2,200 data points, which was more than sufficient for valid multilevel modeling and provided adequate statistical power, but the fact that data points were correlated within a smaller number of individuals did tend to limit conclusions. Second, conclusions about the relationship between VL and adherence must be considered tentative because VL data were gathered from clinic charts and might have been as old as 6 months; i.e., not contemporary with the behavioral measure of adherence. However, other data from the same clinic also suggest good viral suppression despite lower than optimal adherence (Langness, et al., 2014). Third, as described above, there were fewer data points on the measures of stress and coping than on the other momentary state variables because of survey branching rules that were intended to minimize participant burden. This strategy resulted in lower-powered analyses for those two specific variables, which were based on only 487 or 489 data points. This is notable because stress and coping were the only 2 momentary state variables (out of 5 tested) with no indirect effects. Finally, all measures but adherence were based on self-report; even though ecological momentary assessment likely improved accuracy because of its immediacy, survey responses were still based in language and could partially reflect beliefs rather than actual experiences. Future research might be able to circumvent this limitation by including biobehavioral measures of key constructs, for example heart rate variability as a physiological indicator of stress.

Conclusions

Overall, the proposed model in which adherence results from momentary motivation was partially confirmed, with evidence that 3 of the 5 predictors of interest did, in fact, have effects on adherence by way of their effects on motivation. This was relatively strong support for the model despite an absence of direct effects on adherence for any momentary state variable beside mood, because only motivation was expected to have a direct relationship to adherence. All other effects were originally posited to be indirect ones. Clinicians would be well advised to assess motivation because of its link to ART adherence, for example using questions from Herzog and Blatt (2007) about past and predicted behavior. However, our study also highlighted the need to ask about motivation day-by-day rather than just at the time of an office visit.

Based on our analyses and a previous set of analyses that tested direct relationships between predictor variables and ART adherence, the majority of constructs and associations between variables posited in our original model were confirmed in this study. A simpler refinement of the model that includes only those variables with significant associations can be used to guide future intervention studies that offer support to PLWH in the context of their everyday experiences.

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Key Considerations

- Even PLWH with well-controlled HIV have day-to-day variability in adherence.
- HIV care providers should ask patients about daily ups and downs in motivation for treatment, which are likely to affect ART adherence.
- PLWH's daily experiences of control beliefs, mood, and social support all affect adherence indirectly by way of motivation.

Figure 1.

Theoretical model showing predicted effects of momentary states on adherence (adapted with permission from Cook et al., 2010). Solid lines show original predicted relationships. Other than the effect of motivation on adherence, which was confirmed in a prior analysis (Cook et al., 2017), no direct effects of momentary states on adherence behavior were expected. An unexpected direct effect of mood on adherence was found in our prior analysis, and is shown by the dotted line. The current study tested the predicted indirect effects of momentary states on adherence behavior, with motivation as the theoretical mechanism by which they would have their effects. ART = antiretroviral therapy.

Figure 2.

Total sample, stratified by race/ethnicity and gender. Compared to the national HIV epidemic in the United States, this distribution is slightly more skewed toward White men and under-representative of African American men and women. This is the result of population demographics in Colorado, where the study was conducted.

Table 1

Regression Models Testing Momentary State Variables' Effects on Motivation

Predictor	Observations	Beta (se)	t-statistic	p-value
Control Beliefs	2,221	.102 (.012)	8.40	< .0001
Mood	2,219	-.057 (.010)	-5.57	< .0001
Stress	489	.041 (.031)	1.32	0.19
Coping	487	.085 (.021)	4.03	< .0001
Social Support	2,220	.080 (.010)	8.09	< .0001

Note. Each variable was tested in a separate model, with motivation as the criterion variable and number of survey days as a covariate to control for varying amounts of data per individual.

Table 2

Effects of Motivation on Adherence, Adjusted for Momentary State Variables (n = 2,202 unique observations)

Predictor	Beta (se)	Odds ratio (95% CI)	p value
Motivation	.457 (.194)	1.58 (1.08 to 2.31)	.02 *
Control Beliefs	.314 (.184)	1.37 (0.96 to 1.96)	.09
Mood	.474 (.153)	1.61 (1.19 to 2.17)	.002 *
Social Support	-.020 (.136)	0.98 (0.75 to 1.28)	.88

* statistically significant at $p < .05$

Note. All variables were entered simultaneously in a single model, with adherence as the criterion variable and number of survey days as a covariate to control for varying amounts of data per individual.