Published in final edited form as:
J Adv Nurs. 2010 November ; 66(11): 2560–2572. doi:10.1111/j.1365-2648.2010.05400.x.

The HIV Medication Taking Self-Efficacy Scale: Psychometric Evaluation

Judith A. Erlen, PhD, RN, FAAN[Professor][PhD Program Coordinator],
Department Chair of Health and Community Systems, School of Nursing, University of Pittsburgh

EunSeok Cha, PhD, MPH, MSN, RN[Research Associate],
School of Nursing, University of Pittsburgh

Kevin H. Kim, PhD[Associate Professor],
Statistician School of Education, University of Pittsburgh

Donna Caruthers, PhD, RN[Assistant Professor], and
School of Nursing, University of Pittsburgh

Susan M. Sereika, PhD[Associate Professor][Director]
Statistical Support Services, Statistician School of Nursing, University of Pittsburgh

Abstract

Aim—This paper is a report of an examination of the psychometric properties of the HIV Medication Taking Self-efficacy Scale.

Background—Self-efficacy is a critically important component of strategies to improve HIV medication-taking; however, valid and reliable tools for assessing HIV medication-taking self-efficacy are limited.

Method—We used a cross-sectional, correlational design. Between 2003 and 2007, 326 participants were recruited from sites in Pennsylvania and Ohio in the United States of America. Six self-report questionnaires administered at baseline and 12 weeks later during “Improving Adherence to Antiretroviral Therapy” were used to examine the variables of interest. Means and variances, reliability, criterion, and construct validity of the HIV Medication Taking Self-efficacy Scale were assessed.

Findings—Participants reported high self-confidence in their ability to carry out specific medication-related tasks (mean=8.31) and in the medication’s ability to effect good outcomes (mean=8.56). The HIV Medication Taking Self-efficacy Scale and subscales showed excellent reliability (α = .93 ~ .94). Criterion validity was well-established by examining the relationships between the HIV Medication Taking Self-efficacy Scale and selected physiological and

Correspondence concerning this article should be addressed to Judith A Erlen, Department of Health and Community Systems, School of Nursing, University of Pittsburgh, 415 Victoria Building, Pittsburgh PA, 15261, USA. Phone: 1-412-624-1905, jae001@pitt.edu.

Author Contributions:
JAE, ESC, KHK & SMS were responsible for the study conception and design
JAE, DC & SMS performed the data collection
JAE, ESC, KHK & SMS performed the data analysis.
JAE, ESC, KHK, DC & SMS were responsible for the drafting of the manuscript.
JAE, ESC, KHK, DC & SMS made critical revisions to the paper for important intellectual content.
KHK & SMS provided statistical expertise.
JAE obtained funding
DC provided administrative, technical or material support.
JAE, DC & SMS supervised the study

Conflict of interest:
No conflict of interest has been declared by the authors.

psychological factors, and self-reported medication adherence (r = −.20 ~ .58). A two-factor model with a correlation between self-efficacy belief and outcome expectancy fitted the data well (model χ^2 = 3871.95, df = 325, p<001; CFA =.96; RMSEA =.046).

Conclusion—The HIV Medication Taking Self-efficacy Scale is a psychometrically sound measure of medication-taking self-efficacy for use by researchers and clinicians with people with HIV. The findings offer insight into the development of interventions to promote self-efficacy and medication adherence in persons with HIV.

Keywords

HIV Medication Taking Self-Efficacy Scale; psychometric evaluation instrument development; self-efficacy; antiretroviral therapy; nursing

INTRODUCTION

Medication adherence is the degree to which an individual follows or conforms to a prescribed therapeutic regimen (Haynes 1979). Medication adherence rates are influenced by multiple factors such as dosing schedule, length of time on therapy, side effects, meal planning, travel away from home, and the limitations of the treatment regimen related to the clinical outcomes (Kruse *et al.* 1994). Additionally, perceived social support and stigma, emotional well-being, trust of the healthcare provider, and self-efficacy are known to influence medication adherence (Ammassari *et al.* 2002, Roura *et al.* 2009).

Researchers have identified a potential intervening role of self-efficacy in medication adherence in people with HIV (Johnson *et al.* 2006, Simoni *et al.* 2006, Roura *et al.* 2009). Self-efficacy consists of two major components: self-efficacy beliefs and outcome expectancies. Self-efficacy beliefs, or efficacy expectations are defined as a person's own judgment of their ability to perform a specific behavior; outcome expectancy is a person's expectation that engaging in the given behavior will produce the expected positive results (Bandura 1977). Together self-efficacy beliefs and outcome expectancies are dynamically and reciprocally linked, and both are significantly related to a specific behavioral outcome (Bandura 1977, Resnick 2004).

Self-efficacy improves when individuals master a specific behavior, are confident in their ability to achieve the desired behavior in various circumstances, have supportive relationships, and perceive enhanced physical and psychological well-being as outcomes (Bandura 1997). Optimists feel confident that they can attain a desired health outcome (Godin *et al.* 2005) ; however, people who are depressed or experiencing decreased physical health feel less confident in their ability to carry out a particular behavior (Cha *et al.* 2008).

Bandura (1997) asserts that self-efficacy is that operationalized by specific behaviors. No single standardized self-efficacy tool is appropriate for all studies (Resnick 2004). Rather, researchers need to develop a new or modified instrument to measure the specific behavioral phenomenon of interest. No such measure was available when we began our medication adherence study with people with HIV. Therefore, we developed the HIV Medication Taking Self-Efficacy Scale (HIV MT SES) to assess the two major dimensions of antiretroviral medication-taking self-efficacy for the first phase of our research, "Adherence to Protease Inhibitors".

Additionally, HIV affects people globally; the numbers infected in developing countries continue to increase (UNAIDS 2009). Thus, international HIV researchers need a measure to assess self-efficacy that is psychometrically valid and reliable and has the potential for use across cultures. Increasing a person's confidence in their ability to take antiretroviral

medications is necessary for effective self-management and minimizing HIV disease progression regardless of the country in which the individual lives. A psychometrically sound instrument that can be translated into other languages for use in research and clinical practice is needed.

BACKGROUND

Achieving an optimal adherence rate of 95% for HIV control can be difficult for people with HIV (PWHIV) (Lewis *et al.* 2006, Read *et al.* 2003, Parsons *et al.* 2008). Higher rates of adherence are strongly associated with decreased morbidity and mortality in PWHIV (Lewis *et al.* 2006). However, researchers have found that these people discontinue antiretroviral medications on their own or report intentional missed doses and drug holidays (Aversa *et al.* 1998, Aversa & Kimberlin 1996). Non-adherence to antiretroviral medication leads to worsening of symptoms, disease progression, increased viral resistance, decreased quality of life, and higher health care costs (Chesney *et al.* 2000).

Medication-taking self-efficacy has been identified as a statistically consistent and protective factor for self-reported medication non-adherence in people with HIV (Ammassari *et al.* 2002, Johnson *et al.* 2006, Kerr *et al.* 2005). For example, Eldred and colleagues (1998) examined the relationship between adherence and patients' belief in their ability to adhere to therapy. They assessed self-efficacy beliefs, antiretroviral outcome expectancy and Pneumocystis *carinii* pneumonia (PCP) prophylaxis outcome expectancies and found that positive self-efficacy was statistically significantly related to adherence to monotherapy and PCP prophylaxis (Eldred *et al.* 1998). Gifford and colleagues (2000) used a 5-item HIV medication self-efficacy scale adapted from instruments created by Lorig and colleagues (1996) that focused on the self-management of a chronic disorder. Self-efficacy was an independent predictor of antiretroviral adherence in HIV-infected patients who received combination antiretroviral therapy (Gifford *et al.* 2000). An adapted tool by Gifford and colleagues was used in a pilot study conducted by Catz *et al.* (2000). This self-report instrument assessed patients' confidence to manage adherence barriers and tailor their medication regimens. Self-efficacy was significantly related to long-term adherence (Catz *et al.* 2000). Chesney, *et al.* (2000) examined associations between self-efficacy and medication adherence. They found that 26 (36%) of participants who were non-adherent to their regimen had lower self-efficacy beliefs score about their ability to take all or most of their medications as directed, as well as a lower outcome expectancy score for the role of non-adherence to antiretroviral medication and the development of viral resistance.

Recently, more researchers are developing their own HIV self-efficacy scales; however, not all have included an outcome expectation scale. Kerr *et al.* (2005) developed an adherence self-efficacy scale to identify psychosocial predictors of highly active anti-retroviral therapy (HAART) discontinuation in a sample of HIV-positive injection drug users. Lower self-efficacy beliefs and efficacy regulation predicted HAART discontinuation; higher negative outcome expectancies were associated with discontinuing HAART. Godin, *et al.*, (2005) measured self-efficacy beliefs and outcome expectancies regarding the taking of HIV medication using their own measure. In this one-year longitudinal study, higher self-efficacy was associated with better perceived social support and greater patient satisfaction with physician. Johnson, *et al.* (2006), and Simoni, *et al.* (2002, 2006) also developed their own self-efficacy belief scales to assess the mediating role of self-efficacy between psychosocial factors and antiretroviral medication adherence. Self-efficacy belief mediated relationships between positive provider interaction (Johnson *et al.* 2006), needs for social support (Simoni *et al.* 2002), spirituality and negative affect (Simoni *et al.* 2006), and antiretroviral medication adherence. Parsons et al (2008) examined the role of adherence self-efficacy in relation to medication adherence and CD 4 count using their own scale, and found that self-

reported adherence partially mediated the relationship between adherence self-efficacy and viral load.

Instruments are available to measure medication-taking self-efficacy in people with HIV, but employing a valid and reliable measurement of self-efficacy for research is still challenging. Most researchers have only reported the Cronbach alpha for their measures. To overcome the limitations of the previous research, Johnson and colleagues (2007) reported development and validation of their HIV Treatment Adherence Self-Efficacy Scale (HIV-ASES) assessing broader concepts of HIV treatment adherence among general HIV-infected populations. The scale measured individuals' self-efficacy to follow not only antiretroviral therapy, but also overall HIV treatment plans (nutrition, exercise and daily activities) during the past month (Johnson *et al.* 2007). Thus, the scale may be inappropriate for use in a clinical trial examining self-efficacy's role in relation to antiretroviral medication therapy. Table 1 shows tools to measure HIV medication-taking self-efficacy in the literature.

HIV Medication Taking Self-efficacy Scale: development and testing

The HIV MT SES was developed in 1998 to assess a respondent's level of self-efficacy for use in a clinical trial,"Adherence to Protease Inhibitors", designed to test the effectiveness of a nurse-delivered antiretroviral therapy adherence telephone intervention grounded in Bandura's social cognitive and self-efficacy theories. The scale includes items selected to reflect as many different medication-taking situations and potential outcomes of medication-taking which reflect targeted intervention areas to improve medication adherence in people with HIV.

The initial items selected for inclusion in the HIV MT SES were from the literature, a previous qualitative study, and clinical experience. Two subscales, self-efficacy beliefs (SEB) and outcome expectancy (OE), were created based on self-efficacy theory. Content and face validity were assessed by experts including HIV primary healthcare providers and people with HIV participating in our pilot work, respectively (Crocker & Algina 1986). Twenty-six items, 17 assessing self-efficacy beliefs (SEB) and 9 assessing outcome expectancy (OE), were retained.

Preliminary psychometric testing of the HIV MT SES was performed to assess reliability, concurrent validity, and exploratory factor analysis with the participants in the first phase of our research, "Adherence to Protease Inhibitors" (Erlen *et al.* 2001, Cha *et al.* 2004). From 1998 to 2001, participants (male=145, female=70) ranging in age from 19-61 years (mean age = 40.7±7.58) were recruited from multiple sites in Western Pennsylvania, USA, and through self-referral. Selected physiological (e.g., symptom distress) and psychological variables (e.g., depression, optimism, and perceived stigma) identified as predictors of HIV MT SES in previous research and self-efficacy theory were used to assess concurrent validity (Resnick 2004, Godin *et al.* 2005, Cha *et al.* 2008). Internal consistency reliability were excellent (α=.96 for overall scale; α=.96 for SEB; α=.95 for OE). Twelve-week test-retest reliability showed a significantly positive relationship (n=84, r=.58, p <.001). Concurrent validity was well supported with symptom distress (r=−.44, p <.01), depression (r= −.47, p <.001), optimism (r=.43, p <.001), and self-reported medication-taking adherence (r=.51, p <.001). Exploratory factor analysis was performed with principal component extraction and varimax rotation. A two-factor model best fitted the data. The explained variances of the first factor (SEB) and the second factor (OE) were 47.93% and 16.29%, respectively. The total explained variance was 66.21% (Cha *et al.* 2004).

The parent study, "Improving Adherence to Antiretroviral Therapy", was the second phase of our 10-year intervention to improve medication adherence in people with HIV. In that study we tested the efficacy of a multi-component structured nurse intervention grounded in

social-cognitive theory. The participants were randomized to one of two intervention arms or to a usual care/control arm. Those in the intervention arms received a 12-session nurse-delivered telephone intervention that included content related to scheduling, habit formation, feedback, problem solving, self-monitoring, and oral persuasion. One group received the intervention using a structured format and the other group received the intervention delivered in an individualized manner, based on an assessment of their needs related to medication-taking.

THE STUDY

Aim

The overall aim of the study was to further assess the psychometric properties of the HIV Meditation Taking Self-Efficacy Scale (HIV MT SES). Specific aims were to examine: (1) means and variances, (2) reliability (3) criterion validity (concurrent, predictive, and discriminate validity), and (4) construct validity of the HIV MT SES.

Design

An instrument development study was conducted, using a cross-sectional, correlational design.

Participants

Between 2003 and 2007, participants were recruited from HIV/AIDS primary care clinics in western Pennsylvania and eastern Ohio in the USA. Enrolled participants were 18 years of age or older, were able to read and understand English, had access to a telephone and were without HIV dementia as determined by the HIV Dementia Scale (Power *et al.* 1995). Data were collected at five intervals. For this instrumentation study only the baseline and post intervention (12 week) data collected from the participants were used.

Data collection

The self-report questionnaires used in the present instrumentation study were: a sociodemographic questionnaire, the Interpersonal Support Evaluation List, the Medical Outcomes Study-HIV, the Perceived Burden of Medication Regimen Visual Analog Scale, a modified self-report Medication Taking Scale, and the HIV MT SES.

The Socio-demographic questionnaire, developed by the Center for Research in Chronic Disorder, the University of Pittsburgh, included items regarding age, ethnicity, gender, education, current employment, health insurance status, and income.

The Interpersonal Support Evaluation List (ISEL) measured perceived social support. The tool contains 40 items on a 4-point Likert scale. Half of the items are positively worded and half are negatively worded. Overall social support and four separate types of social support were measured: tangible, belonging, appraisal, and self-esteem. Overall scores can range from 0 to120 and the scores for each subscale can range from 0 to 30. Cronbach alpha using a general population was .88 to .90 (Cohen *et al.* 1985). Higher scores indicate greater perceived social support. In this study, Cronbach alpha was .94.

Two subscales, energy/fatigue (4 items) and mental health (5 items), of the Medical Outcomes Study HIV Health Survey (MOS HIV), were used to measure physiological and psychological factors, respectively (Wu *et al.* 1997). Scores for each of the subscales use a transformed 100-point scale. Higher scores indicate better health during the past 4 weeks (i.e., “feel energetic all the time” in energy/fatigue subscale; “feel calm, peaceful and happy all the time” in mental health subscale). Cronbach alphas for the energy/fatigue and mental

health subscales were .87 and .83, respectively (Wu *et al.* 1997). In the current study, Cronbach alphas for the energy/fatigue and the mental health sub-scales were .84 and .86, respectively.

Perceived Burden of Medication Regimen Visual Analog Scale, 2 items, measured participants' perception of the complexity of their medication regimen and the impact of side effects on their daily life. These visual analogue scales were designed specifically for the intervention study. Participants were asked to place a vertical line through the line in the scale (0 [not complex] to 100 [very complex]) to indicate perceived burdens.

The nine-item Morisky Self-reported Medication Taking Scale (MSMTS) was used to measure medication adherence. The first eight items use dichotomous responses of yes=1 or no=0; the last item uses a 5-point Likert scale (not often [1] to often [5]). The possible range of scores for this instrument is 1 to13. Higher scores indicate having less difficulty remembering to take HIV medication (Viswanathan *et al.* 2005). In the current study, Cronbach alpha was .66.

The HIV MT SES measured a person's level of self-efficacy with regard to HIV medication-taking using a 10-point Likert scale (not confident [1] to totally confident [10]). The self-efficacy belief subscale (17 items) assessed confidence to follow the treatment plan or to keep appointments in various situations. The outcome expectancy subscale (9 items) examined expectation that antiretroviral medications would improve health functioning or decrease signs and symptoms related to HIV. Higher scores indicated greater HIV medication-taking self-efficacy.

Ethical considerations

The appropriate ethics committees approved the study. All participants gave informed consent.

Data analysis

The data were analyzed using SPSS for Windows version 16.0 (SPSS Inc, Chicago, IL) and EQS 6.1 (Bentler & Wu 2002). Prior to analysis, all data were examined for the accuracy of data entry, missing values, missing patterns, linearity, and normality for Pearson's product moment correlations. If a variable had less than 10% missing data, then these were imputed with the Expectation Maximization (EM) Method using SPSS 16.0 (Dempster *et al.* 1977). The original data set consisted of 349 respondents. Of these, 6 returned more than two incomplete questionnaires on the baseline measures, 8 were good adherers, 3 were multivariate outliers, and 6 were univariate outliers on the HIVMT SES. These 23 people were excluded from the final analysis. Data from the remaining 326 respondents at baseline and 99 usual care participants at 12 weeks were used in this instrumentation study.

In the parent study, participants were asked to complete study measures including the HIV MT SES at baseline, at 12 (post-intervention), and at three subsequent intervals. We chose the 12-week timeframe to conduct test-retest reliability for this instrumentation study as the primary purpose of the parent study was to test the effectiveness of a telephone-based intervention, and not to examine the psychometric properties of the HIV MT SES. We recognized that multiple factors could have influenced responses at the second data collection; however, a shorter timeframe for examining test-retest reliability was unavailable.

Descriptive statistics were used to examine the mean, variance, and range of scores on the HIV MT SES. Internal consistency using Cronbach coefficient alpha and the Standard Error of Measurement were used to evaluate its reliability (DeVellis 2003, Nitko 2004). The

Standard Error of Measurement was used to examine reliability by estimating the standard deviation of error. The Standard Error of Measurement allows estimation of the difference between a person's actual score and the highest or lowest hypothetical score. The lower Standard Error of Measurement means that the test score is a good estimate of a person's actual score and supports the higher Cronbach alpha (Nitko 2004). Test-retest reliability assessment used a paired t-test to assess stability of the HIV MT SES (DeVellis 2003).

Criterion validity of the HIV MT SES was assessed with concurrent, predictive, and discriminant validity using Spearman rho correlations between the scale and related study measures. The hypotheses tested to assess concurrent validity were: (1) there is a positive relationship between the SEB and OE; (2) higher HIV MT SES is associated with better physiological and psychological health, greater perceived social support, and higher self-reported medication adherence at baseline. The hypothesis tested to examine discriminant validity was that lower scores on the HIV MT SES and its two subscales are significantly associated with greater perceived complexity of the medication regimen and perceived impact of side effects on daily life. The hypothesis tested to assess predictive validity was that higher scores on the HIV MT SES and its two subscales at baseline are positively correlated with self-reported medication adherence at 12 weeks. The level of statistical significance for hypotheses testing was set at .05 (two-tailed).

A confirmatory factor analysis using structural equation modeling was performed to examine the factor structure of the HIV MT SES. Since there were negative skewness and restricted responses of the HIV MT SES, parameter estimates were obtained using bootstrap statistics in EQS 6.1 for Windows. A two-factor model was tested based on Bandura's self-efficacy theory (Bandura 1977, 1997, Resnick 2004) and the preliminary findings of the exploratory factor analysis (Cha *et al.* 2004).

Bootstrapping is a re-sampling procedure to determine the sampling distribution of the parameter estimates and fit indexes. Cases are randomly selected from the original data set to generate other data sets (Kline 1998). This method allows researchers to approximate the sampling distribution of parameter estimates and fit indexes. One hundred bootstrap replications were conducted to assess means, standard deviations, and 95% confidence intervals of model fit and parameter estimates. The Wald test and Lagrange multiplier test were used for model trimming and modification. Greater than .95 of the comparative fit index (CFI) and less than 0.06 of the root mean-square error of approximation (RMSEA) are accepted as the cutoffs of good model fits (Hu & Bentler 1999, Kline 1998).

RESULTS

Demographics

About two-thirds of the 326 respondents (n= 226, 69.3%) were male. The mean age was 43.84 years (SD: 7.97; range: 20-66 years). They were mainly African American (n=183, 56.1%) or Caucasian (n=132, 40.5%). English was the primary language for the most participants (n=319, 97.9%). The average number of years of formal education was 13.06 years (SD: 2.85). Only about one-fifth were either full-time (n=26, 8.0%) or part-time workers (n=34, 10.4%). More than 50% had never been married, while 69 (21.16 %) were living with either a spouse or significant other. Most participants (n=303, 93.0%) currently had health insurance; however, more than half (n=168, 51.5%) reported that they had financial difficulty meeting their basic needs.

Descriptive statistics for study measures

Participants reported high self-confidence in their ability to carry out a specific task and in the medication's ability to produce good outcomes. The mean scores for the SEB and OE

subscales at baseline were 8.31 and 8.56 of 10, respectively (See Table 2). Thirty-three (10%), and 58 (26%) participants selected only a response of 10 for all items in the SEB and OE subscales, respectively. Since the participants were highly confident, a ceiling effect and a social desirability bias may need to be considered when measuring self-efficacy.

Scores on the two subscales of the MOS HIV at baseline demonstrated that respondents felt energetic some of the time and were calm, peaceful and happy most of the time. The visual analog scales showed that they perceived their medication regimens not to be burdensome or complex. They reported moderately high perceived social support. Their self-reported medication adherence scores were quite high, suggesting good adherence to their medication regimen (See Table 2).

Validity

Criterion Validity—Table 3 shows the correlations between scores on the HIV MT SES and selected study variables. The self-efficacy beliefs subscale (SEB) was positively related to the outcome expectancy subscale (OE). Higher HIV MT SES and its subscale scores were significantly associated with better physical and mental health, greater perceived social support, and higher self-reported medication adherence at baseline. When respondents had lower scores on the HIV MT SES and its subscales, they perceived the medication regimen to be more complex, and side effects had a greater impact. Higher scores on the HIV MT SES and its subscales at baseline were positively associated with a higher score for self-reported medication adherence at 12 weeks (See Table 3).

Construct Validity—As an exploratory factor analysis had been conducted in the first phase of our research, the factor structure was assessed using confirmatory factor analysis with bootstrapping method, which offers a much better alternative and imposes no distributional assumptions (Kline 1998). A two-factor model that included the two major dimensions of self-efficacy - self-efficacy beliefs (SEB) and outcome expectancy (OE) - was tested, based on self-efficacy theory (Bandura, 1977) and the findings from the previous exploratory factor analysis. A two-factor model with a correlation between SEB and OE best fitted the data (model χ^2= 3871.95, df=325, p<001; CFA =.96 (95% CIs = .9366 to .9849); RMSEA =.046 (95% CIs: .0289 to .0597). As expected, the SEB and the OE were significantly correlated (Mean of correlation =0.2805 (SD: .0702); 95% CIs: .1684-.3893). Table 4 presents estimated parameters in the model.

Reliability

The HIV SES MT and its subscales showed excellent reliabilities. Cronbach alphas were .93 for HIV MT SES; .94 for SEB; .93 for OE. The standard errors of measurement (SEM) for the overall scale (.35) and for the two subscales (.39 for SEB and .43 for OE) were very low, and supported the high Cronbach alphas. Test–retest reliabilities of the HIV SES MT and its subscales demonstrated significantly positive relationships in a sample of 99 control respondents (r=.73 for HIV MT SES; r=.66 for SEB; r=.73 for OE). The findings demonstrated that the HIV SES MT and its two subscales were reliable and stable.

DISCUSSION

Study limitations

The HIV MT SES was negatively skewed and the reported responses were limited in the current study. The negative skewness of the HIV MT SES refers to a participant's high confidence in their ability to take antiretroviral medications and their expectation of positive outcomes as a result of taking their medications, in spite of challenges related to regimen complexity and side effects. Researchers have identified barriers and challenges such as

busy schedules, lower health literacy, unplanned events, and concerns about inadvertent HIV status disclosure (Kalichman *et al.* 2005). However, cautious interpretation may be required with our findings. Self-efficacy can be misinterpreted by respondents' "wishful thinking", that is people do not actually know how they will perform the behavior as they have not as yet encountered the situation (Resnick 2004). Also, a volunteer sample may report high scores on self-efficacy. For example, our participants perceived less complexity in their medication regimens and experienced fewer side effects (see Table 2). Their scores on the HIV MT SES may be higher than scores from other HIV- infected patients who have more severe HIV-related symptoms, higher perceived medication burden and more side effects from their HIV medications. Further investigations are needed to clarify whether the reported high score on the HIV MT SES is due to patients' actual confidence, successful empirical experiences, underestimation of challenges, the limitation of volunteer sample bias, or social desirability bias.

Evidence of acceptable validity and reliability

The earliest study to address HIV medication-taking self-efficacy is Eldred's (1998), which was published at approximately the same time as the initiation of the first phase of our study. Eldred and colleagues measured self-efficacy beliefs and two types of outcome expectancies: antiretroviral monotherapy outcome expectancy and Pneumocystis *carinii* pneumonia prophylaxis outcome expectancy. However, Eldred's scale was inappropriate for our research because of different sample characteristics (with/without *carinii pneumonia*) and the medication type (mono-therapy vs. combination therapy). Therefore, we developed our scale to assess self-efficacy beliefs under specific situations and outcome expectancy when participants were prescribed combination antiretroviral therapy.

In our study, high Cronbach alpha coefficients were identified, and thus item redundancy was carefully examined. There was a potential item redundancy (social outing vs. a party, r=.90). Additionally, several items (e.g., a party, at an unplanned event, or at a planned event) were highly correlated with each other (r >.80); other items showed no redundancy. However, we intentionally developed the HIV MT SES to measure degree of confidence in very specific situations. Since each item can be operationalized differently in the context of the unique situation of each person with HIV, all items were deemed to be necessary in order to assess self-efficacy beliefs. The reported high internal consistency may be evidence of a reliable instrument rather than item redundancy.

Criterion validity was well-established by examining relationships between the HIV MT SES and selected physiological and psychological factors and self-reported medication adherence. Despite a positive relationship between the HIV MT SES and self-reported medication adherence measure, researchers need to recognize the inherent differences among adherence measures and carefully select the measure of adherence for their studies, because self-report measures frequently over-report actual adherence (Besch 1995, Heckman *et al.* 2004). Researchers also need to consider the use of alternative measures such as electronic event monitors to obtain more accurate actual medication-taking adherence rates (Kruse *et al.* 1994).

Practicability of the scale

Self-efficacy has been identified as a statistically strong predictor or mediator of HIV medication adherence (Cha *et al.* 2008, Johnson *et al.* 2006, Simoni *et al.* 2006). Thus, researchers are developing self-efficacy based interventions to enable patients to achieve an optimal rate of HIV medication adherence. Using an appropriate self-efficacy measure is key to evaluating the success of these interventions. However, few studies have been conducted examining the psychometric properties of a self-efficacy scale for HIV

medication-taking (Kalichman *et al.* 2005, Johnson *et al.* 2007), and conceptual flaws related to total scores assessing variables other than self-efficacy have been identified frequently in reported self-efficacy scales (Forsyth & Carey 1998).

The strengths of our study are that it offers insight into selecting appropriate HIV medication-taking self-efficacy measure, including self-efficacy beliefs and outcome expectancy subscales, for use in research. The study also illustrates a detailed process of tool development and a comprehensive evaluation from initial scale development process to measuring diverse psychometric properties (e.g., predictive and discriminate validity, exploratory factor analysis and confirmatory factor analysis). An additional strength is that the HIV MT SES has been repeatedly assessed with adequate independent samples recruited in two different time periods and demonstrating consistent results. Therefore, the findings of the current study provide researchers and HIV healthcare providers with a psychometrically sound measure of medication-taking self-efficacy for use with people with HIV. Additionally, this study may suggest factors to consider when developing an intervention to promote self-efficacy and medication adherence in people with HIV.

CONCLUSION

The HIV MT SES is a valid and reliable instrument for measuring HIV medication-taking self-efficacy. However, there are several implications for future research. First, the psychometric properties, particularly test-retest reliability, need to be examined in a shorter follow-up period with a larger sample. Second, future testing of the HIV MT SES needs to be conducted with diverse samples such as adolescents, diverse cultural groups, and substance users. Assessing the tool's usefulness for international research is also needed. This will require appropriate translation techniques to achieve not only linguistic equivalence but also functional equivalence in different language versions. Finally, there is much that remains unknown about medication-adherence and self-efficacy in people with HIV, for example the effect of length of time living with HIV, how use of less a complex regimen affects medication adherence, the impact of changed societal perceptions of HIV from that of a fatal disease to a chronic disorder, and how cultural factors affect medication adherence.

Summary Statements

What is already known about this topic

- Self-efficacy is statistically significant predictor of promoting antiretroviral therapy adherence.
- Instruments are available to measure medication-taking self-efficacy in people with HIV, but identifying a valid and reliable measurement of self-efficacy for research remains challenging.

What this paper adds

- Participants reported high self-confidence in their ability to carry out specific medication-related tasks and in the medication's ability to effect good outcomes.
- The HIV Medication Taking Self-efficacy Scale and subscales showed excellent reliability.
- Criterion validity was well-established by examining the relationships between the HIV Medication Taking Self-efficacy Scale and selected physiological and psychological factors, and self-reported medication adherence.

Implications for practice /policy

- The tool's usefulness needs to be assessed with more heterogeneous and international samples.

Acknowledgments

Funding Statement

We acknowledge the National Institute of Nursing Research (1R01 NR04749 and 2R01 NR04749) for its support of this study.

References

Ammassari A, Trotta MP, Murri R, Castelli F, Narciso P, Noto P, Vecchiet J, D'Arminio Monforte A, Wu AW, Antinori A. Correlates and predictors of adherence to highly active antiretroviral therapy: overview of published literature. Journal of Acquired Immune Deficiency Syndromes. 2002; 31(Suppl 3):S123–7. [PubMed: 12562034]

Aversa S, Kimberlin C, Segal R. The Medication Attribution Scale: perceived effects of antiretrovirals and quality of life. Quality of Life Research. 1998; 7(3):205–214. [PubMed: 9584550]

Aversa SL, Kimberlin C. Psychosocial Aspects Of Antiretroviral Medication Use Among Hiv Patients. Patient Education & Counseling. 1996; 29(2):207–219. [PubMed: 9006237]

Bandura A. Self-efficacy: Toward a unifying theory of behavioral change. Psychological Review. 1977; 84(2):191–215. [PubMed: 847061]

Bandura A. Perceived self-efficacy in health-promoting behavior. Health Functioning. 1997:299–302.

Bentler, PM.; Wu, EJC. EQS for Windows user's guide. Multivariate Software, Inc; Encino, CA: 2002.

Besch CL. Compliance in clinical trials. AIDS. 1995; 9(1):1–10. [PubMed: 7893432]

Catz SL, Kelly JA, Bogart LM, Benotsch EG, McAuliffe TL. Patterns, correlates, and barriers to medication adherence among persons prescribed new treatments for HIV disease. Health Psychology. 2000; 19(2):124–33. [PubMed: 10762096]

Cha ES, Erlen JA, Kim KH, Sereika SM, Caruthers D. Mediating roles of medication.taking self-efficacy and depressive symptoms on self-reported medication adherence in persons with HIV: A questionnaire survey. International Journal of Nursing Studies. 2008; 45:1175–1184. [PubMed: 17949723]

Cha ES, Erlen JA, Kim Y. Psychometric evaluation of the HIV self-efficacy scale (HIV SES). Annals of Behavioral Medicine. 2004; 27(Supplement):S148.

Chesney MA, Ickovics JR, Chambers DB, Gifford AL, Neidig J, Zwickl B, Wu AW, Patient Care Committee & Adherence Working Group of the Outcomes Committee of the Adult AIDS Clinical Trials Group (AACTG). Self-reported adherence to antiretroviral medications among participants in HIV clinical trials: the AACTG adherence instruments. AIDS Care. 2000; 12(3):255–66. [PubMed: 10928201]

Cohen, S.; Mermelstein, R.; Kamarck, T.; Hoberman, HM. Measuring the functional components of the social support. In: Sarason, IG.; Sarason, BR., editors. Social support: theory, research, and applications. Kluwer; Boston, MA: 1985.

Crocker, LM.; Algina, J. Introduction to classical and modern test theory. Holt, Rinehart, and Winston; New York: 1986.

Dempster AP, Laird NM, Rubin DB. Maximum likelihood from incomplete data via EM algorithm. Journal of the Royal Statistical Society. 1977; B(39):1–38.

DeVellis, RF. Scale Development: Theory and Applications. Sage Publications, Inc; Thousand Oaks, CA: 2003.

Eldred LJ, Wu AW, Chaisson RE, Moore RD. Adherence to antiretroviral and pneumocystis prophylaxis in HIV disease. Journal of Acquired Immune Deficiency Syndromes & Human Retrovirology. 1998; 18(2):117–25. [PubMed: 9637576]

Erlen, JA.; Mellors, MP.; Serika, SM.; Thato, S. Assessing self-efficacy in persons living with HIV: Tool development; 13th annual scientific sessions of the Eastern Nursing Research Society; 2001; p. 115

Forsyth AD, Carey MP. Measuring self-efficacy in the context of HIV risk reduction: Research challenges and recommendations. Health Psychology. 1998; 17(6):559–568. [PubMed: 9848807]

Gifford AL, Bormann JE, Shively MJ, Wright BC, Richman DD, Bozzette SA. Predictors of self-reported adherence and plasma HIV concentrations in patients on multidrug antiretroviral regimens. Journal of Acquired Immune Deficiency Syndromes. 2000; 23(5):386–95. [PubMed: 10866231]

Godin G, Cote J, Naccache H, Lambert LD, Trottier S. Prediction of adherence to antiretroviral therapy: a one-year longitudinal study. AIDS Care. 2005; 17(4):493–504. [PubMed: 16036235]

Haynes, RB. Introduction. In: Haynes, RB.; Taylor, DW.; Sackett, DL., editors. Compliance in health care. Johns Hopkins University Press; Baltimore: 1979. p. i-xv.

Heckman BD, Catz SL, Heckman TG, Miller JG, Kalichman SC. Adherence to antiretroviral therapy in rural persons living with HIV disease in the United States. AIDS Care. 2004; 16(2):219–30. [PubMed: 14676027]

Hu LT, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. Structural Equation Modeling. 1999; 6(1):1–55.

Johnson MO, Chesney MA, Goldstein RB, Remien RH, Catz S, Gore-Felton C, Charlebois E, Morin SF. Positive provider interactions, adherence self-efficacy, and adherence to antiretroviral medications among HIV-infected adults: A mediation model. AIDS Patient Care STDS. 2006; 20(4):258–68. [PubMed: 16623624]

Johnson MO, Neilands TB, Dilworth SE, Morin SF, Remien RH, Chesney MA. The role of self-efficacy in HIV treatment adherence: Validation of the HIV treatment adherence self-efficacy scale (HIV-ASES). Journal of Behavioral Medicine. 2007; 30:359–370. [PubMed: 17588200]

Kalichman SC, Cain D, Fuhrel A, Eaton L, Di Fonzo K, Ertl T. Assessing medication adherence self-efficacy among low-literacy patients: Development of a pictographic visual analogue scale. Health Education Research. 2005; 20(1):24–35. [PubMed: 15253999]

Kerr T, Marshall A, Walsh J, Palepu A, Tyndall M, Montaner J, Hogg R, Wood E. Determinants of HAART discontinuation among injection drug users. AIDS Care. 2005; 17(5):539–49. [PubMed: 16036240]

Kline, RB. Principles and practice of structural equation modeling. Guilford; New York: 1998.

Kruse W, Rampmaier J, Ullrith G, Weber E. Patters of drug compliance with medication to be taken once and twice daily assessed by continuous electronic monitoring in primary care. International Journal of Clinical Pharmacology Therapy. 1994; 32:452–457.

Lewis MP, Colbert A, Erlen J, Meyers M. A qualitative study of persons who are 100% adherent to antiretroviral therapy. AIDS Care. 2006; 18(2):140–8. [PubMed: 16338772]

Nitko, AJ. Educational assessment of students. Merrill; Englewood Cliffs, NJ: 2004.

Parsons JT, Rosof E, Mustanski B. The temporal relationship between alcohol consumption and HIV-medication adherence: a multilevel model of direct and moderating effects. Health Psychology. 2008; 27(5):628–37. [PubMed: 18823189]

Power C, Selnes OA, Grim JA, McArthur JC. HIV Dementia Scale: a rapid screening test. Journal of Acquired Immune Deficiency Syndromes & Human Retrovirology. 1995; 8(3):273–278. [PubMed: 7859139]

Read T, Mijch A, Fairley CK. Adherence to antiretroviral therapy: are we doing enough? Intern Med J. 2003; 33:254–256. [PubMed: 12752896]

Resnick, B. Self-efficacy. In: Peterson, SJ.; Bredow, TS., editors. Middle range theories. Lippincott Williams & Wilkins; New York: 2004.

Roura M, Busza J, Wringe A, Mbata D, Urassa M, Zaba B, Roura M, Busza J, Wringe A, Mbata D, Urassa M, Zaba B. Barriers to sustaining antiretroviral treatment in Kisesa, Tanzania: a follow-up study to understand attrition from the antiretroviral program. AIDS Patient Care & Stds. 2009; 23(3):203–10. [PubMed: 19866538]

Simoni JM, Frick PA, Huang B. A longitudinal evaluation of a social support model of medication adherence among HIV-positive men and women on antiretroviral therapy. Health Psychology. 2006; 25(1):74–81. [PubMed: 16448300]

Simoni JM, Frick PA, Lockhart D, Liebovitz D. Mediators of social support and antiretroviral adherence among an indigent population in New York City. AIDS Patient Care & STDs. 2002; 16(9):431–9. [PubMed: 12396695]

UNAIDS. AIDS Epidemic Update 2009. 2009. Retrieved from http://www.unaids.org/en/KnowledgeCentre/HIVData/EpiUpdate/EpiUpdArchive/2009/default.asp on 21 December 2009

Viswanathan H, Anderson R, Thomas J III. Evaluation of an Antiretroviral Medication Attitude Scale and Relationships Between Medication Attitudes and Medication Nonadherence. AIDS Patient Care and STDs. 2005; 19(5):306–316. [PubMed: 15916493]

Wu A, Hays R, Kelly S, Malitz F, Bozette S. Applications of the medical outcomes study health-related quality of life measures in HIV/ AIDS. Quality of Life Research. 1997; 6:531–554. [PubMed: 9330553]

Table 1

Medication-taking self-efficacy scales with HIV infection

Authors (year); tool used	Sample	Constructs measured	Reported psychometric properties (s)
Eldred *et al.* (1998); their own scale	244 HIV-infected patients	**1** Self-Efficacy beliefs measured using 5-point scale **2** Outcome Expectancy measured using 5-point scale **i.** Antiretroviral therapy **ii.** Pnemocystis carinii Pneumonia	-Cronbach alpha only **1** Self-efficacy belief scale (9 items, α=. 79). **2** Outcome expectancy scale (# of items was not reported) **i.** Antiretroviral therapy subscale (# of items was not reported, α=.72) **ii.** Pneumocystis carinii pneumonia subscale (# of items was not reported. α =. 77)
Gifford *et al.* (2000); adapted from Lorig's scale (1996) developed for use in chronic disorders	133 HIV-infected patients receiving combination antiretroviral therapy	- HIV medication self-efficacy **i.** Perceived self-efficacy for HIV medication use **ii.** Expectations of behavioral efficacy **iii.** Outcome expectancy	Cronbach alpha only HIV medication self-efficacy scale (5 item, α=.88)
Catz *et al.* (2000); adapted from Gifford and colleagues (1996)	72 HIV-infected participants taking antiretroviral therapy	- Treatment adherence self-efficacy measured using a 10-point scale	Cronbach alpha only Treatment adherence self-efficacy scale (8 items, α=.87)
Chesney *et al.* (2000); No information available	75 HIV-infected patients from 10 adult AIDS clinical trials units	- Adherence self-efficacy and beliefs about medication effectiveness measured using 4-point Likert scale **i.** Self-efficacy belief **ii.** Outcome expectancy	No psychometric properties were reported **i.** Self-efficacy belief scale (3 items) **ii.** Outcome expectancy scale (2 items)
Simoni *et al.* (2002); their own scale	54 HIV-infected patients	- Self-efficacy to adhere to their prescribed medications measured using 4-point Likert scale	Cronbach alpha only Self-efficacy to adhere to the prescribed medications scale (5 items, α=.79)
Simoni *et al.* (2006); their own scale	136 HIV-infected patients	- Self-efficacy to adhere to their prescribed medications measured using 4-point Likert scale	Psychometric properties were not reported Self-efficacy to adhere to the prescribed medications scale (5 items)
Kerr *et al.* (2005); their own scale	160 HIV-infected drug users	**1** Adherence self-efficacy measured using 11-point scale ranging from 0 to 100 **i.** Adherence efficacy expectation **ii.** Self-regulatory efficacy **2** Outcome expectancy measured using 11-point scale ranging from 0 to 100	Cronbach alpha only **1** Adherence self-efficacy scale (8 items; α=.82) **2** Outcome expectancy scale (1 item, α= not available)

Authors (year); tool used	Sample	Constructs measured	Reported psychometric properties (s)
Godin *et al.* (2005); their own scale	361 HIV-infected patients taking antiretroviral therapy for at least 6 month	**1** Self-efficacy beliefs measured using 5-point Likert scale **2** Outcome expectancies measured using 5-point Likert scale	Cronbach alpha and two week test-retest reliability only **1** Self-efficacy belief scale (9 items, α=. 87, two week test –retest reliability (intraclass correlation) =.71) **2** Outcome expectancy scale (8 items, α=. 73; two week test –retest reliability (intraclass correlation) =.75)
Kalichman *et al.* (2005); their own scale	81 lower literacy adults living with HIV-AIDS	- Pictographic HIV treatment self-efficacy for three selected situations: becoming unexpectedly busy in a social situation, oversleeping, and alcohol consumption.	Two-week test-retest reliability (3 items, r(80) = 0.63, $p < 0.01$) Convergent, divergent, criterion validity were validated
Johnson *et al.* (2007); their own scale	3112 HIV-infected patients in two clinical trials of behavioral interventions	-HIV- adherence self-efficacy measured by using 10 point scale **i.** integration **ii.** perseverance	-Global component reliability of HIV-Adherence Self-Efficacy Scale (ASES) (12 items; ρ=.91, 95% CIs: 89-.93 for study 1; ρ=.92, 95% CIs: .91-.92 for study 2 at baseline) Three-month test-retest reliability of HIV-ASES (r=.71, 95% CIs: .62-.80 in integration subscale [9 items]; r=.71, 95% CIs: .56-.86 in perseverance subscale [3 items] for study 1). Construct validity, concurrent validity, divergent validity were validated.
Parsons *et al.* (2008a, 2008b); their own scale	275 HIV-infected patients	-Self- efficacy belief to take HIV medication using 5-point scale	Cronbach alpha only Adherence Self-Efficacy Scale (11 items, α=.91)

Table 2

Descriptive statistics of variables for measures

Variables	Mean ±SD (Median)	Obtained ranges (Possible ranges)	Inter-quartile
Baseline (0 week, n=326)			
HIV MT SES	8.40 ± 1.32 (8.69)	4.04 – 10.00 (1-10)	7.68-9.50
1) Self-efficacy Beliefs Subscale	8.31 ± 1.58 (8.77)	2.94 - 10.00 (1-10)	7.63-9.65
2) Outcome expectancy Subscale	8.56 ± 1.63 (9.00)	2.44 - 10.00 (1-10)	7.89-10.00
MOS-HIV			
-- Energy/fatigue	51.06± 22.86 (50.0)	0.00-100.00 (0-100)	35.00-65.00
-- Mental health	63.20± 23.15 (64.0)	0.00-100.00 (0-100)	48.00-84.00
Perceived Burden of Medication Regimen			
--Complexity of medication regimen	31.16 ± 32.66 (15.50)	0.00 - 100.00 (0-100)	4.00 - 55.00
--Impact of side effects	33.31 ± 31.29 (24.00)	0.00 - 100.00 (0-100)	5.00 - 56.00
Interpersonal Support Evaluation List	1.91 ± 0.57 (1.95)	0.15 - 3.00 (0-3)	1.48 - 2.34
Morisky Self-report Medication Taking	9.76 ± 2.51 (10.00)	2.00 - 13.00 (1-13)	8.00 – 12.00
Post-intervention (12 week, n=99)			
HIV MT SES	8.26 ± 1.56 (8.73)	2.69 - 10.00 (1-10)	7.35 - 9.54
1) Self-efficacy Beliefs Subscale	8.28 ± 1.73 (8.71)	2.00 - 10.00 (1-10)	7.71 - 9.59
2) Outcome expectancy Subscale	8.23 ± 1.96 (9.00)	1.78 - 10.00 (1-10)	7.44 - 10.00
Morisky Self-report Medication Taking	9.66 ± 2.63 (10.00)	3.00 - 13.00 (1-13)	8.00 – 12.00

Table 3

The Criterion validity of the HIV Meditation Taking Self-Efficacy Scale (HIV MT SES)

	HIV medication-taking self-efficacy (0 week)		
	Overall scale	**Self-efficacy beliefs: SEB**	**Outcome expectancy: OE**
SEB at baseline	.91***	-	-
OE at baseline	.68***	.37***	-
Overall scale (12wk)	.66***	.52***	.52***
SEB at 12wk	.58***	.55***	.32**
OE at 12wk	.54***	.30**	.66***
Energy/fatigue	.38***	.28***	.37***
Mental Health	.38***	.29***	.37***
Complexity of medication regimen†	−.20**	−.18**	−.16**
Impact of side effects †	−.29***	−.24***	−.40***
Social Support	.35***	.27***	.37***
Self-report medication-taking (baseline)	.58***	.61***	.24***
Self-report medication-taking (12wk)‡	.41***	.43***	.14*

* $p < .05$

** $p < .01$

*** $p < .001$

† indicates discriminate validity of HIV MT SES

‡ indicates predictive validity of the HIV MT SES

Table 4

Factor structure of a two-factor model with bootstrapping method

Items	Mean of estimated Parameters (SD)	95% Confidence intervals
Self-Efficacy Beliefs (SEB)		
1. Keep a clinic appointment	.40 (.06)	.29 - .48
2. Follow overall treatment regimen	.71 (.04)	.65 - .76
3. Follow a plan for taking HIV medication	.72 (.04)	.66 - .78
4. Taking HIV Medication with correct intervals	.58 (.05)	.49 - .66
5. Take correct dose	.57 (.05).	.49 - .65
6. At work	.71 (.04)	.64 - .77
7. On a weekday	.77 (.04)	.70 - .82
8. On a weekend	.78 (.04)	.72 - .84
9. At social outing	.92 (.01)	.89 - .94
10. At a party	.88 (.03)	.83 - .92
11. At a planned event	.84 (.03)	.78 - .89
12. At an unplanned event	.85 (.02)	.81 - .89
13. At travel	.81 (.03)	.76 - .85
14. Feel well	.63 (.06)	.52 - .73
15. Feel ill	.61 (.05)	.52 - .69
16. Having medication side effects	.53 (.05)	.46 - .61
17. Having in a crisis	.62 (.05)	.53 - .69
Outcome Expectancy (OE)		
1. Your health	.84 (.03)	.79 - .88
2. Quality of life	.86 (.03)	.81 - .90
3. Function ability	.81 (.04)	.74 - .88
4. Allowing a long life	.84 (.03)	.80 - .88
5. Leading a near normal life	.76 (.04)	.68 - .82
6. Decreasing HIV related symptoms	.75 (.04)	.68 - .80
7. Decreasing viral load	.57 (.07)	.44 - .67
8. Increasing T-Cell count	.73 (.04)	.65 - .79
9. Preventing hospitalization	.73 (.04)	.67 - .78