



Mechanism of Change in Cognitive Behavioral Therapy for Body Image and Self-Care on ART Adherence Among Sexual Minority Men Living with HIV

Kalina M. Lamb¹ · Kelsey A. Nogg¹ · Steven A. Safren² · Aaron J. Blashill^{1,3}

Published online: 11 May 2018

© Springer Science+Business Media, LLC, part of Springer Nature 2018

Abstract

Body image disturbance is a common problem reported among sexual minority men living with HIV, and is associated with poor antiretroviral therapy (ART) adherence. Recently, a novel integrated intervention (cognitive behavioral therapy for body image and self-care; CBT-BISC) was developed and pilot tested to simultaneously improve body image and ART adherence in this population. Although CBT-BISC has demonstrated preliminary efficacy in improving ART adherence, the mechanisms of change are unknown. Utilizing data from a two-armed randomized controlled trial (N = 44 sexual minority men living with HIV), comparing CBT-BISC to an enhanced treatment as usual (ETAU) condition, sequential process mediation via latent difference scores was assessed, with changes in body image disturbance entered as the mechanism between treatment condition and changes in ART adherence. Participants assigned to CBT-BISC reported statistically significant reductions in body image disturbance post-intervention, which subsequently predicted changes in ART adherence from post-intervention to long term follow-up ($b = 20.01$, $SE = 9.11$, $t = 2.19$, $p = 0.028$). One pathway in which CBT-BISC positively impacts ART adherence is through reductions in body image disturbance. Body image disturbance represents one, of likely several, mechanism that prospectively predicts ART adherence among sexual minority men living with HIV.

Keywords HIV/AIDS · Body image · ART adherence · Sexual minority men · Mediation

Introduction

Body image disturbance, defined as concern, distress, and dissatisfaction regarding one's appearance [1], is common among sexual minority (e.g., gay and bisexual) men [2, 3]. Indeed, sexual minority men report greater body dissatisfaction compared to their heterosexual counterparts [2, 4]. Typically in Western society, there are sociocultural expectations placed on men to be lean and muscular, and the internalization of these ideals can lead to body image disturbance [5]. A number of factors can also contribute to this internalization; for example, sexual minority males are more likely than heterosexual males to desire the muscular ideal

commonly found in media [3, 6, 7]. In addition, for sexual minority males, increased social comparison is positively related to involvement in the gay community [8]. The gay male community could place greater emphasis on appearance, which in turn could increase social comparison, thus contributing to the greater amount of body image disturbance in this community [9].

Body image disturbance also impacts sexual minority men living with HIV. Up to one-third of sexual minority men living with HIV express elevated body dissatisfaction [10]. Using a biopsychosocial model of body image disturbance in sexual minority men living with HIV, one study found that in addition to sociocultural factors (e.g., appearance investment), biological factors, such as lipodystrophy, contribute to increased body image concerns [11]. Lipodystrophy, the presence of lipoatrophy (a decrease in body fat) or lipohypertrophy (an increase in body fat), is common in individuals living with HIV, caused both by infection and treatment [12, 13]. Lipoatrophy generally occurs in the arms, face, legs, and buttocks, while lipohypertrophy generally occurs in the abdominal region, the neck, or in the form of

✉ Kalina M. Lamb
klamb-sw@sdsu.edu

¹ San Diego State University, San Diego, CA, USA

² University of Miami, Coral Gables, FL, USA

³ San Diego State University/UC San Diego Joint Doctoral Program in Clinical Psychology, San Diego, CA, USA

lipomas [14]. Antiretroviral therapy (ART) has been well documented as a potential cause for lipodystrophy in HIV-infected individuals, however the specific mechanisms are not well understood (see [15, 16] for details on biological pathways). Thus, sexual minority men living with HIV are vulnerable to body image disturbance through both socio-cultural and biological factors.

Body image disturbance itself negatively impacts an individual's mental health; however, it has also been associated with salient HIV related health behaviors, including poor ART adherence [17, 18]. Additionally, a recent study revealed a lipodystrophy prevalence rate of 53% in chronically infected patients undergoing ART exposure, suggesting that lipodystrophy affects a large number of HIV-infected individuals [19]. Lipodystrophy, or fear of lipodystrophy, may be implicated in ART adherence among individuals living with HIV, especially if lipodystrophy is associated with subsequent body image concerns. Not only is ART adherence crucial to individual health, but it is also key from a public health perspective, as high ART adherence leads to HIV viral suppression, which subsequently reduces transmissibility of HIV to 0% [20]. Given that HIV and ART can cause severe fat loss and/or gain that can contribute to body image disturbance and thus poor ART adherence, it may be important to develop interventions aimed at simultaneously improving ART adherence in the context of treating risk factors, such as body image disturbance [21].

Recently, an integrated cognitive behavioral treatment for body image and adherence behaviors was developed and pilot tested among sexual minority men living with HIV [22]. This treatment, coined cognitive behavioral therapy for body image and self-care (CBT-BISC) aimed to simultaneously reduce body image disturbance whilst also improving ART adherence in a structured, modular, 12-session, individually-based therapy. In the pilot study, a randomized controlled trial (RCT) was employed that compared CBT-BISC to an enhanced treatment as usual (ETAU) condition. Although findings provided evidence that CBT-BISC displayed preliminary efficacy in reducing body image disturbance and increasing ART adherence [22], it is currently unclear what mechanisms of action are attributable to the treatment effect on ART adherence. Thus, the aim of the current study was to test the role of body image disturbance as a mechanism in the association between treatment condition and ART adherence. It is hypothesized that assignment to CBT-BISC would lead to significant reductions in body image disturbance, and these reductions would subsequently predict increases in ART adherence. For instance, as CBT-BISC reduces a patient's body image disturbance, the individual may become less invested in his appearance, and subsequently, potential concerns regarding morphological changes due to ART would be reduced, which may lead to increased adherence.

Methods

Study Design and Participants

Participants included 44 sexual minority men living with HIV who reported elevated appearance concerns. There was an equal chance of being randomized to the CBT-BISC condition (22 participants) or the ETAU condition (22 participants). Participants were included in the study if they met the following criteria: (a) HIV-infected; (b) reported oral or anal sex (with or without condoms) with men in the past 12 months; (c) self-identified as male; (d) age 18 to 65 years; (e) prescribed ART for the past 2 months or longer; and (f) significant body image disturbance as indicated by a score of 16 or greater in the Body Dysmorphic Disorder modification of the Yale-Brown Obsessive Compulsive Scale (BDD-YBOCS; [23]). The value 16 was chosen as the cut score for the BDD-YBOCS as it is roughly 0.50 *SD* below the score 20, the minimum score typically used to clinically diagnose body dysmorphic disorder (BDD). Using the value of 16 allowed for participants to be included in the study who experience elevated body image disturbance, although perhaps not at levels consistent with BDD diagnosis, and would still potentially benefit from the intervention. Participants were excluded from the study if they met the following criteria: (a) presence of a severe psychiatric disorder that would interfere with study participation (e.g., unstable bipolar disorder, using the MINI International Neuropsychiatric Interview and modules from the Structured Clinical Interview for the DSM-IV-TR; [24, 25]); and (b) received CBT for body image disturbance within the past 12 months (for more details on study design, see Blashill et al. [22]).

Setting and Recruitment

Study visits occurred at Fenway Health, a community health center in Boston that serves the lesbian, gay, bisexual and transgender (LGBT) community. Recruitment took place primarily at Fenway Health through flyers; however other recruitment strategies were used including community outreach and online advertising on mobile geo-location based social apps targeted towards sexual minority men.

Randomization

Participants were randomly assigned in blocks of four by the study coordinator, and were stratified based on BDD-YBOCS scores. Study condition assignments were concealed from participants and study clinicians until the end of Session 1.

Study Visits

All participants were assessed at baseline to determine eligibility. If eligible, individuals were scheduled for Session 1 roughly 2 weeks after baseline. In the CBT-BISC condition, participants returned for 11 additional, weekly, 50-min individual sessions with a study clinician. In the ETAU condition, participants attended 5 additional biweekly sessions with the program coordinator. Participants additionally completed two follow-up assessments: the first occurred immediately after treatment, approximately 3 months after baseline; the second follow-up occurred approximately 3 months after treatment completion (i.e., 6 months after baseline). Participants received \$310 as compensation throughout the study, both for treatment and assessment sessions.

Measures

Body Image Disturbance

Body image disturbance was assessed using the clinician-administered semi-structured interview, the Body Dysmorphic Disorder modification of the Yale-Brown Obsessive–Compulsive Scale (BDD-YBOCS; [23]). The BDD-YBOCS is a 12-item interview that assesses body image disturbance symptoms over the past week on a 5-point Likert scale ranging from 0 (*least severe*) to 4 (*most severe*). Items were summed to create a total score; higher scores indicated increased body image disturbance. The BDD-YBOCS has demonstrated strong internal consistency, test–retest reliability, and convergent validity [23, 26]. Internal consistency estimates from the current sample ranged from $\alpha = .84$ (baseline) to $\alpha = .93$ (3 month).

ART Adherence

Adherence to ART was assessed using Wisepill, an electronic adherence monitor (Wisepill Technologies, Cape Town, South Africa). Wisepill devices contain 7-day plastic pillboxes that can hold up to 30 pills. Each time the device is opened, a signal is sent to a server in Cape Town, South Africa for recording and access. In previous studies, Wisepill devices have demonstrated feasibility, acceptability, construct validity, and have been found to predict loss of viral suppression [27–29]. Participants were instructed to place inside the device the medication that was most difficult to take or the one taken most frequently if they were unable to fit their full medication regimen into Wisepill. Doses were also counted if a participant could specifically recall the instances in question when they took their medication without using Wisepill, as is consistent in studies involving adherence measures with HIV outcomes [30, 31]. This method has also been utilized in studies on

cognitive behavioral therapy for adherence and depression amongst individuals with HIV, and measures like these have been shown to have improved validity over individual measurements of ART adherence [32–35].

ART adherence scores were calculated in terms of “on-time” adherence (calculated by dividing the number of doses taken within the established time window of 2 h on either side of the scheduled dose by the number of prescribed doses). On-time adherence scores have been found to significantly predict viral load, highlighting the importance of including this measure in HIV research [31, 36, 37], and are also commonly employed in clinical trials examining ART adherence [32–34]. For weekly visit sessions and the two follow-up assessment time points, a past 2-week monitoring period was used to assess adherence outcomes.

Intervention Conditions

Each participant received Session 1 LifeSteps, a single session focusing on ART adherence [38]. After Session 1, the ETAU condition participants met with the project coordinator biweekly over 3 months. During these visits, the program coordinator reviewed participants’ ART adherence as well as made necessary corrections for Wisepill errors, participants completed several brief self-report measures, and lastly the program coordinator provided referral information for mental health treatment. Each of these sessions lasted roughly 15 min.

In the CBT-BISC condition, participants met with a clinician weekly upon completion of Session 1 for 12 sessions total. All sessions involved setting of an agenda, review of adherence, data, review of homework, introduction of new material, and a conclusion with a new homework assignment. CBT-BISC consisted of seven modules focused on body image improvement and various cognitive-behavioral techniques. Module 1 was an orientation to CBT, Module 2 centered on mindfulness and acceptance-based strategies, Module 3 focused on perceptual retraining, Module 4 concentrated on cognitive restructuring, Module 5 was a continuation of exposure-based techniques focused on in Module 3, Module 6 centered on response prevention, and lastly Module 7 focused on relapse prevention. Although the modules were designed to be administered with some flexibility, each participant received at least one session of each module. As there were 7 modules for a 12-session intervention, some modules were included in multiple sessions and were chosen at the discretion of the clinician. Clinicians administering CBT-BISC were either a licensed clinical psychologist, a postdoctoral fellow in clinical psychology, or a predoctoral graduate student in clinical psychology; all had prior experience with CBT.

Statistical Analyses

To assess the mechanisms of change in CBT-BISC on ART adherence, the latent difference score (LDS) method of mediation [39] was employed with Mplus (version 7.4). LDS models are beneficial to assess mediation, as change is overtly assessed via the difference between adjacent time points, which are modeled as a latent variable. In LDS models, change spans a single interval of time, as opposed to an entire trajectory of change, as in the case of latent growth curve modeling. This allows LDS models to specify discrete periods of time in which mediation occurs, and consistent with recommendations in the field, allows for temporal ordering of variables, such that the independent variable (treatment assignment) occurs temporally before the mediator variable (body image disturbance) which occurs before the dependent variable (ART adherence; [40–42]).

In the current study, treatment condition (CBT-BISC vs. ETAU) served as the independent variable. The mediator variable, changes in body image disturbance, was modeled as a latent difference score of changes from baseline to immediate post-intervention, which assesses changes during the active portion of the treatment. The dependent variable, electronically measured on-time ART adherence (via WisePill) was also modeled as a latent difference score of changes in adherence from immediate post-intervention to long-term follow-up, which assessed changes that occurred after the treatment had ended. This sequential process modeling of effects is a temporal requirement for assessing mechanisms of change.

In addition to testing the various pathways of the model, overall model fit was measured with select fit indices. The Chi square/degrees of freedom test, the comparative fit index (CFI), the Tucker–Lewis index (TLI), and the root-mean square error of approximation (RMSEA) were assessed. The ratio of the Chi square to the degrees of freedom is a well-recognized fit index. The CFI and TLI indices are relatively independent of the sample size [43] and the RMSEA provides an index of residual variance. The model is considered to provide an acceptable fit to the data if the following

criteria are met: CFI and TLI above 0.90, RMSEA less than 0.08, and a χ^2 /degrees of freedom ratio below 3.0 [44].

Results

Participants were generally middle-aged adults (M age = 46 years, SD = 11), and were primarily White (64%); however, African American/Black (34%), and Hispanic/Latino (23%) participants were also overrepresented. All participants identified as “gay,” with the exception of one, who reported a bisexual identity. A majority of the sample was not currently working (55%), with 43% of participants receiving social security disability benefits. Overall, the sample was well educated, with a majority (77%) having some college or higher. In regard to psychopathology, the sample exhibited high levels, and substantial psychiatric comorbidity. Indeed, 42 of 44 participants were diagnosed with at least one psychiatric diagnosis, and 73% of the sample was diagnosed with two or more diagnoses. The most common diagnosis was body dysmorphic disorder (68%), followed by major depressive disorder (46%), and generalized anxiety disorder (34%). Overall, the sample was overweight, with a mean body mass index of 27 (SD = 4.9). Lastly, the sample was mostly virally suppressed, with only two participants indicating a detectable viral load, and the mean CD4 count was 820 (SD = 402).

Overall, the data fit the model well: $\chi^2/df = 1.17$, CFI = 0.98, TLI = 0.96, and RMSEA = 0.06. Participants assigned to CBT-BISC reported greater reductions in body image disturbance from baseline to immediate follow-up, compared to those in ETAU ($b = -14.13$, $SE = 2.43$, $t = -5.79$, $p < 0.0001$), indicating that CBT-BISC participants change in BDD-YBOCS scores during the treatment phase reduce by more than 14 points in comparison to the change seen in ETAU participants. Reductions in body image disturbance between baseline and immediate follow-up statistically significantly predicted changes in ART adherence between immediate follow-up and long-term follow-up ($b = -1.41$, $SE = 0.24$, $t = -2.35$, $p = 0.019$), indicating

Table 1 Unadjusted means and standard deviations of adherence and body image disturbance across conditions and time

	Baseline (T1)	3 Month (T2)	6 Month (T3)	<i>d</i> (T2)	<i>d</i> (T3)
BDD-YBOCS					
CBT-BISC	25.36 (6.19)	8.24 (8.95)	8.08 (10.08)	2.39	2.09
ETAU	25.18 (5.15)	21.80 (9.70)	19.87 (12.24)		
Adherence					
CBT-BISC	78.24 (18.66)	88.22 (19.51)	86.55 (23.07)	0.94	0.93
ETAU	85.60 (15.52)	79.29 (24.34)	77.91 (23.87)		

CBT-BISC cognitive behavioral therapy for body image and self-care, ETAU enhanced treatment as usual, BDD-YBOCS the body dysmorphic disorder modification of the Yale-Brown obsessive-compulsive scale, *d* Cohen's *d*

that change of a 1-point decrease in BDD-YBOCS scores during active treatment predicted a subsequent change of nearly a 1.5% increase in ART adherence from end of treatment to follow-up. Subsequently, the indirect effect from treatment condition to changes in ART adherence through changes in body image disturbance was statistically significant ($b=20.01$, $SE=9.11$, $t=2.19$, $p=0.028$). See Table 1 for means and standard deviations of study variables across time.

Discussion

The current study examined the mechanism through which CBT-BISC improved ART adherence among sexual minority men living with HIV. Results indicated that body image disturbance was a statistically significant mechanism, with decreases in body image disturbance contributing to increases in ART adherence following CBT-BISC, an intervention aimed at improving both body image disturbance and ART adherence. These results suggest that body image disturbance may be an important variable to consider in ART adherence interventions, and that the intervention effects followed a pattern of change consistent with the general conceptual model underlying the intervention approach.

Results from a previous study [22] demonstrated preliminary efficacy of CBT-BISC, but did not examine the mechanisms by which the intervention improved ART adherence. We found that participants in the CBT-BISC condition displayed substantial reductions in body image disturbance and depression, as well as improved global functioning, at the end of the intervention and at follow-up as compared to the treatment as usual group. Participants in the CBT-BISC condition also reported higher on-time ART adherence, compared to the ETAU condition, across the treatment period, as well as higher total adherence and fewer depressive symptoms at follow-up. Based on the results of this efficacy trial, it was not clear whether changes in body image disturbance or other variables (e.g., learned adherence skills) were driving the treatment effect on ART adherence. However, the current study shows that change in body image disturbance is indeed one mechanistic pathway from the CBT-BISC intervention to improved adherence. As articulated in the introduction, one reason that addressing body image disturbance may be particularly effective in this group, is that lipodystrophy contributes to elevated levels of body image disturbance in individuals living with HIV [10, 11]. In addition to the infection itself, ART has been associated with lipodystrophy [19], and lipodystrophy has been associated with failure to maintain long-term adherence [45]. Thus, elevated appearance concerns may lead individuals to be less adherent to their ART regimen, especially if they are

concerned that the treatment may confer further undesirable changes in body composition.

While these results highlight the significance of body image disturbance as one mechanism, it is possible that other mechanisms contributed to the improvement of ART adherence in this study. For instance, greater HIV adherence self-efficacy has been associated with greater ART adherence [46]. Those with greater HIV adherence self-efficacy feel their illness is less intrusive, possess stronger coping self-efficacy, and report being more engaged in care than those with lower HIV adherence self-efficacy. Thus, CBT-BISC may also increase participants' feelings of self-efficacy, thereby subsequently increasing ART adherence. Adherence self-efficacy may therefore be an additional factor in understanding the mechanisms of ART adherence improvement.

There are some important limitations to note in the current study. First, ART adherence was operationalized as "on-time" adherence. Due to advances in HIV treatment, it may be less important for people living with HIV to take ART at a specified time. However, on-time adherence has also been found to account for significant variance in viral load, over and above, total adherence, underscoring its clinical significance [30, 36], and a priori was our outcome variable, similar to other studies focused on CBT for ART adherence [26–28]. Additionally, the current study consisted of a relatively small sample; thus, caution should be used in generalizing findings. However, these promising findings may inform future, larger scale studies. Finally, the last follow-up period in this study was 3 months after the completion of the intervention. The long-term effects of body image disturbance as a treatment mechanism are therefore unknown. Future studies may benefit from additional follow-up time points to examine if improving body image disturbance continues to affect adherence across a longer time period.

The current study's findings suggest that body image disturbance contributes to poor ART adherence in sexual minority men living with HIV. As such, clinicians targeting improvements in medication adherence may wish to consider efforts to reduce body image disturbance, as it is associated with poor negative health outcomes and several health risk behaviors [11]. This is especially important for sexual minority men living with HIV, as they report elevated rates of body dissatisfaction [10]. Treating body image disturbance may also increase ART adherence, thereby reducing viral load, and ultimately reducing the risk of transmission of HIV [20] which is important to both individual patients and public health. Clinicians may want to consider utilizing the CBT-BISC modules found in the primary outcome paper [22] during treatment, as it has been shown to effectively improve ART adherence and reduce body image concerns. In sum, these findings have implications for clinical practice, as screening for and targeting body image disturbance

may be an important step in improving ART adherence and reducing HIV transmission.

Acknowledgements Funding from this project came from K23MH096647. Author time for Dr. Safren was supported by K24DA040489 (formally K24MH094214). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institute of Mental Health or the National Institutes of Health.

Funding This study was funded by K23MH096647. Author time for Dr. Safren was supported by K24DA040489 (formally K24MH094214).

Compliance with Ethical Standards

Conflict of interest All authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

References

- Thompson JK, Heinberg LJ, Altabe M, Tantleff-Dun S. *Exacting beauty: theory, assessment, and treatment of body image disturbance*. Washington, DC: American Psychological Association; 1999.
- Morrison MA, Morrison TG, Sager CL. Does body satisfaction differ between gay men and lesbian women and heterosexual men and women? A meta-analytic review. *Body Image*. 2004;1(2):127–38.
- Frederick DA, Essayli JH. Male body image: the roles of sexual orientation and body mass index across five national. *Psychol Men Masc*. 2016;17(4):336–51.
- Peplau LA, Frederick DA, Yee C, Maisel N, Lever J, Ghavami N. Body image satisfaction in heterosexual, gay, and lesbian adults. *Arch Sex Behav*. 2009;38(5):713–25.
- Cafri G, Yamamiya Y, Brannick M, Thompson JK. The influence of sociocultural factors on body image: a meta-analysis. *Clin Psychol*. 2005;12(4):421–33.
- Austin SB, Ziyadeh N, Kahn JA, Camargo CA Jr, Colditz GA, Field AE. Sexual orientation, weight concerns, and eating-disordered behaviors in adolescent girls and boys. *J Am Acad Child Adolesc Psychiatry*. 2004;43(9):1115–23.
- Carper TL, Negy C, Tantleff-Dunn S. Relations among media influence, body image, eating concerns, and sexual orientation in men: a preliminary investigation. *Body Image*. 2010;7(4):301–9.
- Levesque MJ, Vichesky DR. Raising the bar on the body beautiful: an analysis of the body image concerns of homosexual men. *Body Image*. 2006;3(1):45–55.
- Yelland C, Tiggemann M. Muscularity and the gay ideal: body dissatisfaction and disordered eating in homosexual men. *Eat Behav*. 2003;4(2):107–16.
- Sharma A, Howard AA, Klein RS, Schoenbaum EE, Buono D, Webber MP. Body image in older men with or at-risk for HIV infection. *AIDS Care*. 2007;19(2):235–41.
- Blashill AJ, Goshe BM, Robbins GK, Mayer KH, Safren SA. Body image disturbance and health behaviors among sexual minority men living with HIV. *Health Psychol*. 2014;33(7):677–80.
- Caron-Debarle M, Lagathu C, Boccarda F, Vigouroux C, Capeau J. HIV-associated lipodystrophy: from fat injury to premature aging. *Trends Mol Med*. 2010;16(5):218–29.
- Finkelstein JL, Gala P, Rochford R, Glesby MJ, Mehta S. HIV/AIDS and lipodystrophy: implications for clinical management in resource-limited settings. *J Int AIDS Soc*. 2015;18:19033.
- Moreno S, Miralles C, Negredo E, Domingo P, Estrada V, Gutiérrez F, et al. Disorders of body fat distribution in HIV-1-infected patients. *AIDS Rev*. 2009;11(3):126–34.
- Fiorenza CG, Chou SH, Mantzoros CS. Lipodystrophy: pathophysiology and advances in treatment. *Nat Rev Endocrinol*. 2011;7(3):137–50.
- Lake JE, Stanley TL, Apovian CM, Bhasin S, Brown TT, Capeau J, et al. Practical review of recognition and management of obesity and lipohypertrophy in human immunodeficiency virus infection. *Clin Infect Dis*. 2017;64(10):1422–9.
- Blashill AJ, Bedoya CA, Mayer KH, O’Cleirigh C, Pinkston MM, Remmert JE, et al. Psychosocial syndemics are additively associated with worse ART adherence in HIV-infected individuals. *AIDS Behav*. 2015;19(6):981–6.
- Blashill AJ, Vander Wal JS. The role of body image dissatisfaction and depression on HAART adherence in HIV positive men: tests of mediation models. *AIDS Behav*. 2010;14(2):280–8.
- Price J, Hoy J, Ridley E, Nyulasi I, Paul E, Woolley I. Changes in the prevalence of lipodystrophy, metabolic syndrome and cardiovascular disease risk in HIV-infected men. *Sex Health*. 2015;12(3):240–8.
- Gunthard HF, Saag MS, Benson CA, del Rio C, Eron JJ, Gallant JE, et al. Antiretroviral drugs for treatment and prevention of HIV infection in adults: 2016 recommendations of the International Antiviral Society-USA panel. *JAMA*. 2016;316(2):191–210.
- Blashill AJ, Perry N, Safren SA. Mental health: a focus on stress, coping, and mental illness as it relates to treatment retention, adherence, and other health outcomes. *Curr HIV/AIDS Rep*. 2011;8(4):215–22.
- Blashill AJ, Safren SA, Wilhelm S, Jampel J, Taylor SW, O’Cleirigh C, et al. Cognitive behavioral therapy for body image and self-care (CBT-BISC) in sexual minority men living with HIV: a randomized controlled trial. *Health Psychol*. 2017;36:937–46.
- Phillips KA, Hart AS, Menard W. Psychometric evaluation of the Yale-Brown obsessive-compulsive scale modified for body dysmorphic disorder (BDD-YBOCS). *J Obsessive Compuls Relat Disord*. 2014;3(3):205–8.
- Leclercq Y, Sheehan DV, Weiller E, Amorim P, Bonora I, Sheehan KH, et al. The Mini International Neuropsychiatric Interview (MINI). A short diagnostic structured interview: reliability and validity according to the CIDI. *Eur Psychiatry*. 1997;12(5):224–31.
- First MB, Spitzer RL, Gibbon M, Williams JB. *Structured clinical interview for DSM-IV-TR axis I disorders, research version, patient edition (SCID-I/P)*. New York: New York State Psychiatric Institute Biometrics Research; 2002.
- Phillips KA, Diaz SF. Gender differences in body dysmorphic disorder. *J Nerv Ment Dis*. 1997;185:570–7.
- Haberer JE, Kahane J, Kigozi I, Emenyonu N, Hunt P, Martin J, et al. Real-time adherence monitoring for HIV antiretroviral therapy. *AIDS Behav*. 2010;14(6):1340–6.
- Haberer JE, Kiwanuka J, Nansera D, Muzoora C, Hunt PW, So J, et al. Realtime adherence monitoring of antiretroviral therapy

- among HIV-infected adults and children in rural Uganda. *AIDS*. 2013;27(13):2166–8.
29. Orrell C, Cohen K, Leisegang R, Bangsberg DR, Wood R, Maartens G. Comparison of six methods to estimate adherence in an ART-naive cohort in a resource-poor setting: which best predicts virological and resistance outcomes? *AIDS Res Ther*. 2017;14(1):20.
 30. Liu H, Golin CE, Miller LG, Hays RD, Beck CK, Sanandaji S, et al. A comparison of multiple measures of adherence to protease inhibitors. *Ann Intern Med*. 2001;134:968–77.
 31. Liu H, Miller LG, Hays RD, Golin CE, Wu T, Wenger NS, et al. Repeated measures longitudinal analyses of HIV virologic response as a function of percent adherence, dose timing, genotypic sensitivity, and other factors. *J Acquir Immune Defic Syndr*. 2006;41(3):315–22.
 32. Safren SA, Bedoya CA, O’Cleirigh C, Biello KB, Pinkston MM, Stein MD, et al. Cognitive behavioural therapy for adherence and depression in patients with HIV: a three-arm randomised controlled trial. *Lancet HIV*. 2016;3:e529–38.
 33. Safren SA, O’Cleirigh C, Tan JY, Raminani SR, Reilly LC, Otto MW, et al. A randomized controlled trial of cognitive behavioral therapy for adherence and depression (CBT-AD) in HIV-infected individuals. *Health Psychol*. 2009;28:1–10.
 34. Safren SA, O’Cleirigh CM, Bullis JR, Otto MW, Stein MD, Pollack MH. Cognitive behavioral therapy for adherence and depression (CBT-AD) in HIV-infected injection drug users: a randomized controlled trial. *J Consult Clin Psychol*. 2012;80(3):404–15.
 35. Llabre MM, Weaver KE, Duran RE, Antoni MH, McPherson-Baker S, Schneiderman N. A measurement model of medication adherence to highly active antiretroviral therapy and its relation to viral load in HIV-positive adults. *AIDS Patient Care STDS*. 2006;20(10):701–11.
 36. Gill CJ, Sabin LL, Hamer DH, Keyi X, Jianbo Z, Li T, et al. Importance of dose timing to achieving undetectable viral loads. *AIDS Behav*. 2010;14(4):785–93.
 37. Parienti JJ, Barrail-Tran A, Duval X, Nembot G, Descamps D, Vigan M, et al. Adherence profiles and therapeutic responses of treatment-naive HIV-infected patients starting boosted atazanavir-based therapy in the ANRS 134-COPHAR 3 trial. *Antimicrob Agents Chemother*. 2013;57(5):2265–71.
 38. Safren SA, Otto MW, Worth JL. Life-steps: applying cognitive behavioral therapy to HIV medication adherence. *Cogn Behav Pract*. 1999;6:332–41.
 39. Selig JP, Preacher KJ. Mediation models for longitudinal data in developmental research. *Res Hum Dev*. 2009;6(2–3):144–64.
 40. Maxwell SE, Cole DA. Bias in cross-sectional analyses of longitudinal mediation. *Psychol Methods*. 2007;12(1):23–44.
 41. Maxwell SE, Cole DA, Mitchell MA. Bias in cross-sectional analyses of longitudinal mediation: partial and complete mediation under an autoregressive model. *Multivar Behav Res*. 2011;46(5):816–41.
 42. Mitchell MA, Maxwell SE. A comparison of the cross-sectional and sequential designs when assessing longitudinal mediation. *Multivar Behav Res*. 2013;48(3):301–39.
 43. Floyd FJ, Widaman KF. Factor analysis in the development and refinement of clinical assessment instruments. *Psychol Assess*. 1995;7:286–99.
 44. Hu LT, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Struct Equ Model*. 1999;6:1–55.
 45. Duran S, Savès M, Spire B, Cailleton V, Sobel A, Carrieri P, et al. Failure to maintain long-term adherence to highly active antiretroviral therapy: the role of lipodystrophy. *AIDS*. 2001;15:2441–4.
 46. 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). *J Behav Med*. 2007;30:359–70.