Published in final edited form as:

Health Psychol. 2017 January ; 36(1): 91–100. doi:10.1037/hea0000382.

Positive Affect and its Association with Viral Control among Women with HIV Infection

Tracey E. Wilson[1], **Jeremy Weedon**[2], **Mardge H. Cohen**[3], **Elizabeth T. Golub**[4], **Joel Milam**[5], **Mary A. Young**[6], **Adebola A. Adedimeji**[7], **Jennifer Cohen**[8], and **Barbara L. Fredrickson**[9]

[1]Dept of Community Health Sciences, State University of New York Downstate Medical Center

[2]Dept of Epidemiology and Biostatistics, State University of New York Downstate Medical Center

[3]Depts of Medicine, Stroger Hospital of Cook County Bureau of Health and Hospital Systems and Rush University

[4]Bloomberg School of Public Health, Johns Hopkins University

[5]Dept of Preventive Medicine, Keck School of Medicine, University of Southern California

[6]School of Medicine, Georgetown University Medical Center

[7]Department of Epidemiology and Population Health, Albert Einstein College of Medicine

[8]Dept of Clinical Pharmacy, University of California, San Francisco

[9]Dept of Psychology, University of North Carolina at Chapel Hill

Abstract

Objective—We assessed the relationship between positive affect and viral suppression among women with HIV infection.

Method—Three waves of six-month data were analyzed from 995 women on HIV antiretroviral therapy participating in the Women's Interagency HIV Study (10/11–3/13). The predictor variable was self-reported positive affect over two waves of data collection, and the outcome was suppressed viral load, defined as plasma HIV-1 RNA <200 copies/mL, measured at a third wave.

Results—Women with higher positive affect (36%) were more likely to have viral suppression at a subsequent wave (OR 1.92, 95% CI 1.34-2.74). Adjusting for covariates and their interactions, including negative affect, wave one viral suppression, adherence, study site, recruitment cohort, substance use, heavy drinking, relationship status, interpersonal difficulties, and demographics, a statistically significant interaction was detected between negative affect, positive affect and viral suppression ($t(965) = -2.7$, $p=0.008$). The association of positive affect and viral suppression differed at negative affect quartile values. For those reporting no negative affect, the AOR for positive affect and viral suppression was 2.41 (95% CI 1.35-4.31); at a negative affect score of 2, the AOR was 1.44 (95% CI 0.87-2.36); and at a score of 5.5, the AOR was 0.58 (95% CI 0.24-1.42).

Conclusion—Our central finding related to the interaction effect, that positive affect is associated with viral control under conditions of lower negative affect, is consistent with previous theory and research with other health outcomes, and can help guide efforts to further delineate mechanisms linking affect and health.

Keywords

HIV; positive affect; viral load; women

A growing body of work supports the idea that positive affect, which includes positive emotions, has a causal influence on health related outcomes. Emotions are brief affective responses to an appraisal of a situation; when that appraisal is good, positive emotions such as joy, interest, gratitude, hope, or amusement are produced (Fredrickson, 2013a; Watson, Clark, & Tellegen, 1988). While positive emotions are often viewed as a subset of the broader concept of positive affect (Fredrickson, 2001), many researchers use the terms interchangeably.

Research demonstrates the role of higher positive affect on decreased stroke and frailty risk in older adults (Ostir, Markides, Peek, & Goodwin, 2001; Ostir, Ottenbacher, & Markides, 2004; Park-Lee, Fredman, Hochberg, & Faulkner, 2009), hospital readmissions following a cardiovascular event (Middleton & Byrd, 1996), and risk for the common cold in the general population (Cohen, Doyle, Turner, Alper, & Skoner, 2003). In one of the largest analyses on positive affect and mortality, data from 3,853 participants aged 52-79 in the English Longitudinal Study of Ageing were utilized to examine how variations in positive affect are associated with risk of death. In this study, aggregate momentary assessments of positive affect, measured in a single day, were associated with a lower risk of death over a five year follow-up period, after controlling for negative affect, depressed mood, health indicators at baseline, and health behaviors (Steptoe & Wardle, 2011). Other mortality and survival studies have been less definitive, with some supporting an association with positive affect, others failing to find a relationship, and still others showing that high positive affect is associated with a greater mortality risk (Cohen & Pressman, 2006; Diener & Chan, 2011). To date, there has been limited information specifically on the role of positive affect on HIV outcomes. In one study of 1,809 HIV-infected, AIDS-free men from the Multicenter AIDS Cohort Study, there was no relationship detected between positive affect scores at initial study visits and survival over an eight-year observation period (Lyketsos et al., 1993). A subsequent analysis of 407 men from the San Francisco Men's Health Study examined the relationship between cumulative average positive affect scores and mortality over seven years; those findings demonstrated lower mortality among those with higher positive affect (Moskowitz, 2003). To our knowledge, these relationships have not been examined among women with HIV in the era of widespread effective HIV antiretroviral therapy (ART), although one study did examine positive affect as one of several psychological resources available to women with HIV; that study suggested that greater numbers of positive resources overall are associated with increased survival (Ickovics et al., 2006).

There are several pathways by which positive affect may influence health. Positive affect may play a key role in the stress response process, serving as a buffer that decreases the intensity of, and speeds recovery from, stressful events (Fredrickson & Levenson, 1998). Among participants exposed to a stressful task, for instance, those with the highest positive affect at baseline produced less of the inflammatory marker of plasma fibrinogen, as compared to those with the lowest positive affect (Steptoe, Wardle, & Marmot, 2005).

Similarly, the release of the stress hormone cortisol, a marker of stress, has been shown to be lower among those with high positive affect, particularly when salivary cortisol is assessed upon waking (Dockray & Steptoe, 2010; Steptoe, Dockray, & Wardle, 2009). There is also evidence that positive affect is linked to overall reductions in immune system activation (Segerstrom & Sephton, 2010; Steptoe et al., 2005).

Positive affect may also influence health behaviors through the building of psychosocial resources that support health behavior. For instance, positive affect has been linked to the motivation and ability to build intrapersonal and interpersonal resources, including social support (Fredrickson, Cohn, Coffey, Pek, & Finkel, 2008). Higher social support, in turn, is linked to improved health through the provision of emotional and instrumental resources that support self-care behaviors (Schwarzer & Leppin, 1991; Tay, Tan, Diener, & Gonzalez, 2013). In addition, higher levels of positive affect facilitate creativity in problem solving situations; those with positive affect have a wider array of response options available to them (Fredrickson & Branigan, 2005). This may translate to greater capacity to engage in health protective behaviors in the face of barriers.

The broaden-and-build theory of positive emotions (Fredrickson, 1998, 2001, 2013a) posits a unifying approach to understanding how positive affect both buffers the impact of stressful events on health, and through which positive emotions can serve to build relationships and psychological resources such as resilience. The building of resources helps to construct a broader base in which these resources can continue to grow (Fredrickson, 2013a). The theory suggests that those with positive affect are more likely to engage in health protective behaviors, such as medication adherence. For example, in a study of patients with coronary heart disease, positive affect was associated with physical activity, medication adherence, and nonsmoking at baseline, and increases in positive affect over five years corresponded with improvements in physical activity and medication adherence (Sin, Moskowitz, & Whooley, 2015). In terms of HIV, among 153 newly diagnosed participants who identified primarily as gay or bisexual, higher positive affect was associated with increased linkage to care (Carrico & Moskowitz, 2014). Similarly, positive affect was associated with greater ART adherence among 122 primarily male HIV positive methamphetamine users (Carrico, Johnson, Colfax, & Moskowitz, 2010).

Identifying the role of positive affect on the health of women with HIV is important, given a literature suggesting that positive affect is modifiable in the context of health promotion interventions, and can translate into improved health behaviors. Recently, this work has been translated to include health outcomes in the context of intervention trials, when results of three RCTs of the same positive affect intervention were reported from three patient populations (hypertensive African American men and women, patients recently having undergone coronary angioplasty, and patients with asthma, with health education as control). Findings were mixed, with the hypertensive trial showing statistically significant improvements at one year in medication adherence, but with no impact on systolic or diastolic blood pressure (Ogedegbe et al., 2012), the coronary angioplasty group having significantly greater energy expenditure as compared to controls (Peterson et al., 2012), and with the trial with asthma patients showing no statistically significant effects of the positive affect intervention on physical activity (Mancuso et al., 2012).

In this study, we examined data on positive affect among a sample of women living with HIV. This analysis describes three waves of data collection, each spaced six months apart. We examined positive affect across the first two waves, and assessed the relationship between these measures of positive affect and HIV RNA viral load suppression, a marker of disease control, at a subsequent wave, after controlling for negative affect and other potentially influential covariates. Because viral suppression is strongly predicted by a number of behavioral factors encompassing the continuum of HIV care, including adherence and retention in care (Eaton, Saag, & Mugavero, 2014; Yehia et al., 2015), and because positive affect is theoretically and empirically linked to HIV adherence and retention in other populations living with HIV, we hypothesized that higher levels of positive affect would be associated with a greater likelihood of viral suppression.

Method

Participants

This study utilized data from the Women's Interagency HIV Study (WIHS). The WIHS is the largest prospective, multisite cohort study of HIV infection among women in the United States, with study sites in Bronx/Manhattan, NY; Brooklyn, NY; Washington, DC; San Francisco/Bay Area, CA; Los Angeles/Southern California; and Chicago, IL. Eligibility criteria for women with HIV include positive HIV antibody status confirmed by Western blot, an age of 13 years or older, and the ability to answer questions in English or Spanish. Enrollment in the WIHS began in 1994-1995, with an initial cohort of 2,054 women with HIV infection and 569 HIV-uninfected women matched by age, race/ethnicity, and HIV risk factors (i.e., injection drug use history and number of sexual partners). In 2001-2002, an additional 737 women with HIV infection and 406 HIV-uninfected women were enrolled; these women were similar to the original cohort in terms of proportion of HIV-positive and HIV-negative women in each of the matching categories. In 2011-2012, the WIHS recruited an additional 276 HIV-infected and 95 HIV-uninfected women.

Procedures

All participants provide written informed consent and complete study visits every six months. Depending on site, women are remunerated the equivalent of $50-$60 per study visit to cover time and transportation costs. Study visits include interviews administered by centrally trained interviewers using standardized methods, physical exam, and collection of blood, gynecologic, and urine samples, which are stored in a central repository. Study retention, defined as the proportion of enrolled, alive women who were seen in the past year, has been high among the WIHS women with HIV; among those recruited in the first cohort, 83% were still active at the tenth study visit, and among those recruited in the second cohort, 86% were still active at the tenth study visit (Hessol et al., 2009); retention rates for the full HIV+ WIHS sample exceeded 75% at the most recent study visit. All instruments and study protocols were approved by the Institutional Review Board at each participating site. Additional details on the WIHS methodology and baseline characteristics of study participants have been published previously (Bacon et al., 2005; Barkan et al., 1998).

This analysis included data from three consecutive study visits, denoted as wave 1 (10/2011-3/2012), wave 2 (4/2012-9/2012), and wave 3 (10/2012-3/2013). The primary predictor, positive affect, was examined at waves 1 and 2. The dependent variable, HIV RNA viral load, was assessed at wave 3, but also included as a covariate at wave 1. HIV medication adherence, a key determinant of therapeutic success, was included at wave 2; because of this focus, we included only women on ART at wave 3. Adherence was selected as a covariate at wave 2 as opposed to wave 1, given research showing close temporal relationships between treatment interruptions and viral detection (Genberg et al., 2012). Overall, this design permits an examination of positive affect prior to our outcome measure, and controlling for the value of viral control at wave 1, thereby decreasing the likelihood that positive affect is a product of current physical health.

Approximately 2,008 HIV-infected WIHS participants were alive during the observation period. Of these, 140 had been de-activated from the study (e.g., due to moving away from WIHS sites), and another 109 had voluntarily withdrawn prior to the end of wave 1. Of the remaining 1,759 women, 1,264 (72%) contributed positive affect data to both waves 1 and 2. Of those 1,264 women, 995 (79%) had blood drawn at wave 3 for HIV RNA testing, were on ART, and provided information on patterns of ART adherence. An assessment of whether the 995 women included in the analysis differed from the 269 not included in the analysis revealed no statistically significant group differences in positive affect ($p = 0.54$).

Materials and procedure

HIV RNA viral suppression—The primary outcome, plasma HIV-1 RNA quantification, is performed at each study visit. For our analysis, we utilized a cutoff value for the assay of 200 copies/mL; those below this level were categorized as having viral suppression. This cutoff is currently used by the Centers for Disease Control and Prevention to characterize HIV viral control nationally (Bradley et al., 2014).

Positive affect—Positive affect, the primary predictor, was assessed through a subscale of the CES-D (Radloff, 1977). The CES-D is a 20 item, self-report measure, which assesses the burden of depressive symptoms, and which contains four sub-factors: positive affect (4 items), negative affect (7 items), somatic disturbances (7 items), and interpersonal difficulties (2 items) (Joseph & Lewis, 1995). The CES-D has been shown to have strong validity and reliability in several HIV epidemiologic studies (Burack et al., 1993; Ickovics et al., 2001; Lyketsos, Hoover, & Guccione, 1996; Thomas, Jones, Scarinci, Mehan, & Brantley, 2001). A higher burden of depressive symptoms as assessed via the CES-D has been shown to be associated with decreased ART use and higher AIDS-related mortality in the WIHS (Cook et al., 2002; Cook et al., 2004).

The four factor structure of the CES-D has been supported in several studies (Joseph & Lewis, 1995; Knight, Williams, McGee, & Olaman, 1997; Shafer, 2006), including studies focused primarily on minority women (Williams et al., 2007). In the CES-D measurement of burden of depression symptoms, low scores on positive affect are one of four factors that contribute to risk for depression. The positive affect subscale items, however, have also been validated as an independent indicator of higher positive affect, and not just absence of

negative affect; thus, this subscale has been successfully utilized in several studies examining the role of positive affect on health and survival (Blazer & Hybels, 2004; Krijthe et al., 2011; Moskowitz, 2003; Ostir et al., 2001; Park-Lee et al., 2009). Respondents are asked to rate how often over the past seven days they have experienced a range of depressive symptoms. Each item includes a choice of four responses: 0 = *rarely or none of the time/less than a day*, 1 = *some or a little of the time/1-2 days*, 2 = *occasionally or a moderate amount of the time/3-4 days*, or 3 = *most days or all of the time/5-7 days*. The four positive affect items in the CES-D ask how often respondents (1) felt just as good as other people, (2) felt hopeful about the future, (3) felt happy, and (4) enjoyed life. The items are summed, with a possible range of 0 to 12; higher scores indicate higher positive affect.

Analysis of the four positive affect items demonstrated adequate internal consistency (Cronbach's alpha = 0.80 at both wave 1 and 2). However, an examination of the distribution of scores at waves 1 and 2 revealed a clear cutpoint in the distribution, with 51% of women reporting positive affect on all or most days of the week across all four items at wave 1, 50% reporting positive affect across all items at wave 2, and 36% reporting high positive affect at both waves, with a fairly equal distribution of responses across the other scale response options (skewness = -1.1). For this reason, the positive affect score was dichotomized; high positive affect was defined as a report of positive affect on all or most days of the week across all four positive affect items at both waves 1 and 2.

HIV antiretroviral therapy (ART) adherence—Antiretroviral regimens were assessed using photocards, medication bottles, or by obtaining pharmacy records. This system allows for an assessment of initiation and persistence of therapy over time (Bae, Guyer, Grimm, & Altice, 2011). Adherence is measured via self-report at every study visit utilizing 6-month recall assessments; participants are asked to report the percent of their regimen that they took over that time (e.g., *none of the time*, *less than 75% of the time*, *75-94% of the time*, *95-99% of the time*, 100% of the time). Responses were dichotomized such that 0 = *less than 95%*, 1 = *greater than or equal to 95%* In the WIHS, self-reported adherence ≥ 95% has been associated with undetectable viral load and higher quality of life (Kapadia et al., 2008; Lazo et al., 2007; Wilson et al., 2002).

Additional covariates—Age, and race/ethnicity were examined as potential covariates of interest, given known disparities in HIV viral control as a function of these factors (Horberg et al., 2015), as was relationship status (reporting being married, in a common law marriage, or living with a partner) at the time of the wave 1 interview (Johnson et al., 2012). Measures of heavy drinking and of crack, cocaine, or heroin use (“substance use”) were included given their established relationships with adherence and viral control among women with HIV infection (Binford, Kahana, & Altice, 2012; Hendershot, Stoner, Pantalone, & Simoni, 2009). Substance use is assessed with quantity/frequency measures of each substance, which are valid and reliable indicators of drug use severity (McLellan et al., 1992; McLellan et al., 1985). At each study visit, women are asked whether they had used crack, cocaine, or heroin since the last interview. We selected these over other substances, such as amphetamines, due to their closer association with disease risk and progression, because they are the substances most frequently reported in the WIHS, and based on their association with ART use and

depression in the cohort (Cook et al., 2008; Cook et al., 2007); substance use was defined as any substance use at either wave 1 or wave 2. Heavy drinking at wave 1 or 2 was defined as more than seven drinks per week (Esser et al., 2014).

Analyses also included the wave 1 and 2 values of the three other CES-D subscales (somatic disturbances, negative affect, and interpersonal difficulties) in order to help isolate the impact of positive affect over that of negative affect and other symptoms of depression, given the clear body of evidence supporting the relationships between depression, poorer adherence and HIV treatment outcomes (Nanni, Caruso, Mitchell, Meggiolaro, & Grassi, 2015). Response options for these subscales are identical to the positive affect subscale; the range of responses for both the negative affect subscale and the somatic subscale is 0-21, with higher scores indicating more negative affect and greater somatic difficulties. These subscales exhibited adequate internal consistency at wave 1 (Cronbach's alpha for negative affect = 0.90; for somatic symptoms = 0.77; for interpersonal challenges = 0.73) and at wave 2 (Cronbach's alpha for negative affect = 0.89; for somatic symptoms = 0.76; for interpersonal challenges = 0.68). Most women (61%) reported no interpersonal challenges across the two waves; this variable was dichotomized in subsequent analyses (skewness = 2.1).

Site of study recruitment and recruitment cohort were included based on differences in WIHS study retention (Hessol et al., 2009). Language of administration (English or Spanish) and country of birth (U.S. versus foreign born) were included because differential item functioning analyses have been utilized to suggest that the positive affect items in the CES-D may be under-endorsed among foreign-born Hispanic populations, thus potentially inflating estimates of depression symptoms in this population (Iwata, Turner, & Lloyd, 2002).

Data analysis

We used Pearson chi-square and t-tests to examine associations of positive affect and our viral suppression outcome variable with model covariates. We then constructed in two stages a generalized linear mixed model to predict viral suppression, modelled as Bernoulli-distributed.

In stage 1 (covariates only), wave 1 values were included for age (4 groups), race/ethnicity (4 groups), recruitment site (6 sites), enrollment cohort (3 cohorts), whether born in the US, whether interviewed in Spanish, presence of a spouse/partner, and viral suppression; wave 2 values were included for ART adherence; averaged wave 1 and 2 values were included for substance use, heavy drinking, interpersonal problems, negative affect score, and somatic burden score. Variance inflation factors were inspected, to ensure that the predictors were not unreasonably multicollinear. The possible utility of polynomial effects in the two scored covariates was investigated. Interaction terms among the covariates were introduced where statistically significant; for this purpose, a somewhat stringent 0.01 significance threshold was used to minimize over-fitting, given the large number of possible interactions. Kenward-Rogers adjustments to standard errors (SEs) & denominator degrees of freedom (*df*) were made.

In stage 2, dichotomized positive affect averaged across waves 1 and 2 was added to the model; interactions of this with other predictors were investigated. The Nagelkerke pseudo-R^2 statistic and the *c* statistic (area under the receiver operating characteristic curve) are reported at each stage as measures of overall model utility. The Hosmer-Lemeshow test of fit of model to data was applied at each stage. Reported results are based on study sites being modelled as a random rather than fixed effect, in order to minimize the size of the model. Extremely similar results were seen when fixed effects were substituted; R^2, *c* & the goodness of fit test come from the fixed-effects model. Adjusted odds ratios (AORs) for positive affect, the predictor of interest, are reported, along with 95% confidence intervals (CIs). Data modelling was done with SAS (SAS Institute, Cary NC) version 9.4 software (PROC GLIMMIX, LOGISTIC).

Results

Participants ranged in age from 28 to 77 years old (mean = 48, SD = 8) and identified primarily as non-Hispanic Black (58%), or as Hispanic (27%). One-quarter (25%) were foreign-born, and 13% completed the interview in Spanish. About one third (32%) were married, in a common-law marriage, or living with a partner. Recent substance use was reported by 7% of women, and 13% were classified as heavy drinkers. In terms of overall burden of depression symptoms, 28% of women at wave 1 scored at the traditional threshold of 16 or higher on the CES-D, and 30% did so at wave 2 (Radloff, 1977), indicating significant burden of depressive symptoms. Adherence at wave 2 of 95% or greater was reported by 83% of women. At wave 1, 77% of women were classified as virally suppressed, and at wave 3, 81% were virally suppressed.

Over one-third of women (N = 361/995) met criteria for high positive affect, and among those with high positive affect, most (68%; N = 245/361) reported a score of below “1” on the negative affect subscale, suggesting very low negative affect. Those categorized as high positive affect were more likely to have viral suppression at the final wave (OR 1.92, 95% CI 1.34, 2.74). As shown in Table 1, positive affect was significantly associated with several posited covariates and predictors. As would be expected, high positive affect was inversely associated with other CES-D subfactors; those with high positive affect reported lower average levels of negative affect, lower average somatic burden, and were more likely to report having no interpersonal difficulties as compared to women with lower positive affect (all $p < 0.001$). Higher positive affect was also associated with a greater likelihood of wave 1 viral suppression ($p = 0.001$) and with wave 2 adherence to ART ($p = 0.005$). Women with high positive affect were also less likely to report recent substance use than were women with low positive affect and more likely to report being married or living with a sexual partner ($p < 0.001$). No statistically significant differences were detected between those reporting low and high positive affect as a function of age, race/ethnicity, country of birth, heavy alcohol use, or language in which the interview was administered (all $p > 0.05$), although there were differences as a function of enrollment cohort ($p = 0.02$) and by study site of recruitment ($p < 0.001$).

Four women had unknown viral load status at wave 3, leaving N=991 for the regression model, of whom 801 had undetected virus at study endpoint. After stage 1 of the modeling

process, R^2 was 0.41, *c* was 0.86, lack of fit test χ^2 (8) = 7.39, $p = 0.495$. After stage 2, R^2 was 0.42, *c* was 0.86, lack of fit test χ^2 (8) = 7.54, $p = 0.479$. A statistically significant interaction between the predictors representing positive and negative affect was detected (t (965) = −2.65, $p = 0.008$), suggesting that the adjusted relationship between positive affect and viral suppression depends upon values of negative affect. To illustrate this effect, we estimated the AOR for high positive affect at quartile-defining values of negative affect (Q1=0, median=2, Q3=5.5). In this model, for the 26% of women in this sample reporting zero on the negative affect subscale, the AOR was 2.41 (95% CI 1.35, 4.31); among those scoring 2, the AOR attenuates to 1.44 (95% CI 0.87, 2.36); and among those scoring 5.5, the AOR was 0.58 (95% CI 0.24, 1.42). A test for an interaction between interview language and adherence on viral load suppression, adjusted for all other variables in the model, was not statistically significant ($p = 0.24$), suggesting that the relationship between positive affect and viral control did not differ between those who preferred the interview in Spanish versus English.

Discussion

In this national study of women living with HIV, those reporting high positive affect over two consecutive six-month study visits were 1.9 times more likely to have undetectable viral load at a subsequent observation period in unadjusted analysis. However, the identification of a statistically significant interaction suggests that the adjusted relationship between positive affect and viral suppression diminishes in the context of higher negative affect. This finding is consistent with the broaden and build theory, which posits that the benefits of positive emotions, at least in the context of measures of overall well-being, are most apparent when they occur with greater regularity than negative emotions (Fredrickson, 2013b).

It is notable that over one-third of women reported high positive affect in this sample, and that of these women, most also reported low levels of negative affect. Such a high level of positive affect and low negative affect may appear counterintuitive among a population living with a chronic disease such as HIV, given that it is both a biologic and social phenomenon, and often co-occurs with a number of factors that would impact poor mental health, including high levels of depression, poverty, substance use, gender-based violence, and racism (Gielen et al., 2007; Meyer, Springer, & Altice, 2011). In addition, there is some evidence that the burden of the disease, associated symptoms, and HIV-related stigma increase risk for depression (Ickovics et al., 2001; Logie & Gadalla, 2009; Vanable, Carey, Blair, & Littlewood, 2006), although the relationship between depression symptoms and stigma has not been consistent across all research studies (Emlet et al., 2013). Reasons for high positive affect and low negative affect among a large subset of participants within the WIHS are yet to be explained, but could be understood in part due to the fact that the majority of women in this study are receiving HIV care, as reflected in rates of ART utilization, and receive additional support as part of their participation in the study. Care and treatment of HIV reduces opportunistic infections, while ancillary services that are often provided as part of HIV care, such as case management, substance use treatment, and mental health counseling, may improve HIV care and promote overall quality of life (Higa, Marks, Crepaz, Liau, & Lyles, 2012; Magnus et al., 2001).

Our findings are generally consistent with those from an earlier study of survival among HIV-infected men who have sex with men studied from 1984 to 1996 in the San Francisco Men's Health Study. In that study, which took place prior to the era of highly effective HIV antiretroviral therapy, men with higher cumulative average positive affect on the CES-D positive affect subscale had a significantly lower risk of death from AIDS (Moskowitz, 2003).

The broaden and build theory suggests that there are several psychosocial pathways by which positive affect may influence HIV care engagement and adherence, including building social support (Fredrickson et al., 2008; Kok et al., 2013; Schwarzer & Leppin, 1991; Tay et al., 2013), facilitating greater attention to health-relevant information and creativity in problem solving situations (Fredrickson & Branigan, 2005; Salovey, Rothman, Detweiler, & Steward, 2000), and promoting psychological resilience during times of stress (Fredrickson, 1998, 2001, 2013a). Further research in this area should clarify mediating pathways and identify generalizability of these findings across risk groups, such as by race/ethnicity, gender, and HIV risk category.

From a public health standpoint, these findings are important given that there are an increasing number of interventions available that have the potential to be implemented at a population level and which have been shown to effectively promote well-being in general and positive affect specifically (Bolier et al., 2013; Cohn & Fredrickson, 2010; Howell, Kern, & Lyubomirsky, 2007; Sin & Lyubomirsky, 2009). These interventions include but are not limited to meditation (Kok et al., 2013), gratitude-enhancing exercises (Boehm, Lyubomirsky, & Sheldon, 2011; Sheldon & Lyubomirsky, 2006), and self-affirmation (Peterson et al., 2012). Given that cultural considerations should drive selection and implementation of positive affect interventions (Boehm et al., 2011), there still is work to be done to identify acceptability of these interventions among women living with HIV. Further, experimental work is required regarding translation of effective positive affect-inducing interventions to the HIV primary care setting, as an adjunct to more traditional clinical and mental health services. This would require consideration of whether positive affect can be increased and sustained at an effect size large enough to produce health improvement even in the context of elevated negative affect.

These findings need to be considered within a set of limitations. Although we utilized a prospective design that assessed viral load following our assessments of positive affect, and controlled for some factors that are associated with greater health at the start of the observation period (e.g., somatic symptoms of depression, substance use, and viral suppression), we are unable to rule out alternative pathways. For instance, it is still plausible that increased positive affect follows from being and feeling healthy, and that it is differences in health at baseline that account for the finding of greater viral control at follow-up. Further research is warranted to assess temporal patterns of affect and to establish greater evidence for causal pathways.

Another limitation is the reliance on self-report to assess positive affect in this study. Several researchers have criticized available measures of positive affect, given that current mood and context may influence estimates of more stable affective states, and that the measures are

subject to recall bias (Kahneman & Krueger, 2006). Several biological markers of positive affect have been investigated. For instance, there is growing evidence to suggest that lower salivary cortisol levels are associated with higher positive affect, and importantly are independent of depressed mood and negative affect (Polk, Cohen, Doyle, Skoner, & Kirschbaum, 2005; Steptoe et al., 2005). Other research suggests that positive affect is related to greater parasympathetic control in general and to faster cardiovascular recovery following experimentally induced negative emotions (Fredrickson, Mancuso, Branigan, & Tugade, 2000; Steptoe et al., 2009). For future research examining the potential impact of positive affect-inducing interventions on HIV control, additional validated measures of positive affect could be supplemented with biologic correlates to help triangulate the findings.

In summary, this study supports the relationship between positive affect and viral suppression, under conditions of lower negative affect. Should subsequent research identify a causal mechanism for the influence of positive affect on these outcomes, a next step could involve development of interventions designed to effectively promote and sustain positive affect as a complement to HIV clinical and mental health screening and treatment programs.

Acknowledgments

Data in this manuscript were collected by the Women's Interagency HIV Study (WIHS). The contents of this publication are solely the responsibility of the authors and do not represent the official views of the National Institutes of Health (NIH). WIHS (Principal Investigators): Bronx WIHS (Kathryn Anastos), U01-AI-035004; Brooklyn WIHS (Howard Minkoff and Deborah Gustafson), U01-AI-031834; Chicago WIHS (Mardge Cohen), U01-AI-034993; Metropolitan Washington WIHS (Mary Young), Connie Wofsy Women's HIV Study, Northern California (Ruth Greenblatt, Bradley Aouizerat, and Phyllis Tien), U01-AI-034989; WIHS Data Management and Analysis Center (Stephen Gange and Elizabeth Golub), U01-AI-042590; Southern California WIHS (Alexandra Levine and Marek Nowicki), U01-HD-032632.

The WIHS is funded primarily by the National Institute of Allergy and Infectious Diseases (NIAID), with additional co-funding from the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD), the National Cancer Institute (NCI), the National Institute on Drug Abuse (NIDA), and the National Institute on Mental Health (NIMH). Targeted supplemental funding for specific projects is also provided by the National Institute of Dental and Craniofacial Research (NIDCR), the National Institute on Alcohol Abuse and Alcoholism (NIAAA), the National Institute on Deafness and other Communication Disorders (NIDCD), and the NIH Office of Research on Women's Health. WIHS data collection is also supported by UL1-TR000004 (UCSF CTSA).

Many thanks to Drs. James Pawelski, Judith Saltzberg-Levick, and to Daniel Lerner of the University of Pennsylvania MAPP program for their support and feedback during the planning stages of this work, and to Susan Holman RN, MS of the SUNY Downstate Medical Center STAR Program for her contributions.

References

Bacon MC, von Wyl V, Alden C, Sharp G, Robison E, Hessol N, et al. Young MA. The Women' Interagency HIV Study: An observational cohort brings clinical sciences to the bench. Clin Diagn Lab Immunol. 2005; 12(9):1013–1019. [PubMed: 16148165]

Bae JW, Guyer W, Grimm K, Altice FL. Medication persistence in the treatment of HIV infection: a review of the literature and implications for future clinical care and research. AIDS. 2011; 25(3): 279–290. [PubMed: 21239892]

Barkan SE, Melnick SL, Preston-Martin S, Weber K, Kalish LA, Miotti P, et al. Feldman J. The Women's Interagency HIV Study. Epidemiology. 1998; 9(2):117–125. [PubMed: 9504278]

Binford MC, Kahana SY, Altice FL. A systematic review of antiretroviral adherence interventions for HIV-infected people who use drugs. Curr HIV/AIDS Rep. 2012; 9(4):287–312. [PubMed: 22936463]

Blazer DG, Hybels CF. What symptoms of depression predict mortality in community-dwelling elders? J Am Geriatr Soc. 2004; 52(12):2052–2056. [PubMed: 15571541]

Boehm JK, Lyubomirsky S, Sheldon KM. A longitudinal experimental study comparing the effectiveness of happiness-enhancing strategies in Anglo Americans and Asian Americans. Cogn Emot. 2011; 25(7):1263–1272. [PubMed: 21432648]

Bolier L, Haverman M, Westerhof GJ, Riper H, Smit F, Bohlmeijer E. Positive psychology interventions: A meta-analysis of randomized controlled studies. BMC Public Health. 2013; 13:119. [PubMed: 23390882]

Bradley H, Hall HI, Wolitski RJ, Van Handel M, Stone AA, LaFlam M, et al. Frazier EL. Vital signs: HIV diagnosis, care, and treatment among persons living with HIV—United States, 2011. MMWR Morb Mortal Wkly Rep. 2014; 63(47):1113–1117. [PubMed: 25426654]

Burack JH, Barrett DC, Stall RD, Chesney MA, Ekstrand ML, Coates TJ. Depressive symptoms and CD4 lymphocyte decline among HIV-infected men. JAMA. 1993; 270(21):2568–2573. [PubMed: 7901433]

Carrico AW, Johnson MO, Colfax GN, Moskowitz JT. Affective correlates of stimulant use and adherence to anti-retroviral therapy among HIV-positive methamphetamine users. AIDS and Behavior. 2010; 14(4):769–777. [PubMed: 19125321]

Carrico AW, Moskowitz JT. Positive affect promotes engagement in care after HIV diagnosis. Health Psychology. 2014; 33(7):686–689. [PubMed: 24245846]

Cohen S, Doyle WJ, Turner RB, Alper CM, Skoner DP. Emotional style and susceptibility to the common cold. Psychosom Med. 2003; 65(4):652–657. [PubMed: 12883117]

Cohen S, Pressman SD. Positive affect and health. Current Directions in Psychological Science. 2006; 15(3):122–125.

Cohn MA, Fredrickson BL. In search of durable positive psychology interventions: Predictors and consequences of long-term positive behavior change. J Posit Psychol. 2010; 5(5):355–366. [PubMed: 21709728]

Cook JA, Burke-Miller JK, Cohen MH, Cook RL, Vlahov D, Wilson TE, et al. Grey DD. Crack cocaine, disease progression, and mortality in a multicenter cohort of HIV-1 positive women. AIDS. 2008; 22(11):1355–1363. [PubMed: 18580615]

Cook JA, Cohen MH, Burke J, Grey D, Anastos K, Kirstein L, et al. Young M. Effects of depressive symptoms and mental health quality of life on use of highly active antiretroviral therapy among HIV-seropositive women. J Acquir Immune Defic Syndr. 2002; 30(4):401–409. [PubMed: 12138346]

Cook JA, Grey D, Burke J, Cohen MH, Gurtman AC, Richardson JL, et al. Hessol NA. Depressive symptoms and AIDS-related mortality among a multisite cohort of HIV-positive women. Am J Public Health. 2004; 94(7):1133–1140. [PubMed: 15226133]

Cook JA, Grey DD, Burke-Miller JK, Cohen MH, Vlahov D, Kapadia F, et al. Levine AM. Illicit drug use, depression and their association with highly active antiretroviral therapy in HIV-positive women. Drug Alcohol Depend. 2007; 89(1):74–81. [PubMed: 17291696]

Diener E, Chan M. Happy people live longer: Subjective well-being contributes to health and longevity. Applied Psychology: Health and Well-Being. 2011; 3(1):1–43.

Dockray S, Steptoe A. Positive affect and psychobiological processes. Neuroscience & Biobehavioral Reviews. 2010; 35(1):69–75. [PubMed: 20097225]

Eaton EF, Saag MS, Mugavero M. Engagement in human immunodeficiency virus care: Linkage, retention, and antiretroviral therapy adherence. Infect Dis Clin North Am. 2014; 28(3):355–369. [PubMed: 25151561]

Emlet CA, Brennan DJ, Brennenstuhl S, Rueda S, Hart TA, Rourke SB. Protective and risk factors associated with stigma in a population of older adults living with HIV in Ontario, Canada. AIDS Care. 2013; 25(10):1330–1339. [PubMed: 23452022]

Esser MB, Hedden SL, Kanny D, Brewer RD, Gfroerer JC, Naimi TS. Prevalence of alcohol dependence among US adult drinkers, 2009-2011. Preventing Chronic Disease. 2014; 11(1-11)

Fredrickson BL. What good are positive emotions? Rev Gen Psychol. 1998; 2(3):300–319. [PubMed: 21850154]

Fredrickson BL. The role of positive emotions in positive psychology. The broaden-and-build theory of positive emotions. Am Psychol. 2001; 56(3):218–226. [PubMed: 11315248]

Fredrickson BL. Positive emotions broaden and build. Advances in Experimental Social Psychology. 2013a; 4747:1–53.

Fredrickson BL. Updated thinking on positivity ratios. Am Psychol. 2013b; 68(9):814–822. [PubMed: 23855895]

Fredrickson BL, Branigan C. Positive emotions broaden the scope of attention and thought-action repertoires. Cogn Emot. 2005; 19(3):313–332. [PubMed: 21852891]

Fredrickson BL, Cohn MA, Coffey KA, Pek J, Finkel SM. Open hearts build lives: positive emotions, induced through loving-kindness meditation, build consequential personal resources. J Pers Soc Psychol. 2008; 95(5):1045–1062. [PubMed: 18954193]

Fredrickson BL, Levenson RW. Positive emotions speed recovery from the cardiovascular sequelae of negative emotions. Cogn Emot. 1998; 12(2):191–220. [PubMed: 21852890]

Fredrickson BL, Mancuso RA, Branigan C, Tugade MM. The undoing effect of positive emotions. Motiv Emot. 2000; 24(4):237–258. [PubMed: 21731120]

Genberg BL, Wilson IB, Bangsberg DR, Arnsten J, Goggin K, Remien RH, et al. Liu H. Patterns of antiretroviral therapy adherence and impact on HIV RNA among patients in North America. AIDS. 2012; 26(11):1415–1423. [PubMed: 22767342]

Gielen AC, Ghandour RM, Burke JG, Mahoney P, McDonnell KA, O'Campo P. HIV/AIDS and intimate partner violence: Intersecting women's health issues in the United States. Trauma Violence Abuse. 2007; 8(2):178–198. [PubMed: 17545573]

Hendershot CS, Stoner SA, Pantalone DW, Simoni JM. Alcohol use and antiretroviral adherence: Review and meta-analysis. J Acquir Immune Defic Syndr. 2009; 52(2):180–202. [PubMed: 19668086]

Hessol NA, Weber KM, Holman S, Robison E, Goparaju L, Alden CB, et al. Ameli N. Retention and attendance of women enrolled in a large prospective study of HIV-1 in the United States. J Womens Health (Larchmt). 2009; 18(10):1627–1637. [PubMed: 19788344]

Higa D, Marks G, Crepaz N, Liau A, Lyles C. Interventions to improve retention in HIV primary care: A systematic review of US studies. Current HIV/AIDS Reports. 2012; 9(4):313–325. [PubMed: 22996171]

Horberg MA, Hurley LB, Klein DB, Towner WJ, Kadlecik P, Antoniskis D, et al. Silverberg MJ. The HIV care cascade measured over time and by age, sex, and race in a large national integrated care system. AIDS Patient Care STDS. 2015; 29(11):582–590. [PubMed: 26505968]

Howell RT, Kern ML, Lyubomirsky S. Health benefits: Meta-analytically determining the impact of well-being on objective health outcomes. Health Psychology Review. 2007; 1(1):83–136.

Ickovics JR, Hamburger ME, Vlahov D, Schoenbaum EE, Schuman P, Boland RJ, Moore J. Mortality, CD4 cell count decline, and depressive symptoms among HIV-seropositive women: Longitudinal analysis from the HIV Epidemiology Research Study. JAMA. 2001; 285(11):1466–1474. [PubMed: 11255423]

Ickovics JR, Milan S, Boland R, Schoenbaum E, Schuman P, Vlahov D. Psychological resources protect health: 5-year survival and immune function among HIV-infected women from four US cities. AIDS. 2006; 20(14):1851–1860. [PubMed: 16954726]

Iwata N, Turner RJ, Lloyd DA. Race/ethnicity and depressive symptoms in community-dwelling young adults: A differential item functioning analysis. Psychiatry Res. 2002; 110(3):281–289. [PubMed: 12127478]

Johnson MO, Dilworth SE, Taylor JM, Darbes LA, Comfort ML, Neilands TB. Primary relationships, HIV treatment adherence, and virologic control. AIDS Behav. 2012; 16(6):1511–1521. [PubMed: 21811842]

Joseph S, Lewis CA. Factor analysis of the Center for Epidemiological Studies-Depression Scale. Psychol Rep. 1995; 76(1):40–42. [PubMed: 7770591]

Kahneman D, Krueger AB. Developments in the measurement of subjective well-being. The Journal of Economic Perspectives. 2006; 20(1):3–24.

Kapadia F, Vlahov D, Wu Y, Cohen MH, Greenblatt RM, Howard AA, et al. Wilson TE. Impact of drug abuse treatment modalities on adherence to ART/HAART among a cohort of HIV seropositive women. Am J Drug Alcohol Abuse. 2008; 34(2):161–170. [PubMed: 18293232]

Knight RG, Williams S, McGee R, Olaman S. Psychometric properties of the Centre for Epidemiologic Studies Depression Scale (CES-D) in a sample of women in middle life. Behaviour Research and Therapy. 1997; 35(4):373–380. [PubMed: 9134792]

Kok BE, Coffey KA, Cohn MA, Catalino LI, Vacharkulksemsuk T, Algoe SB, et al. Fredrickson BL. How positive emotions build physical health: Perceived positive social connections account for the upward spiral between positive emotions and vagal tone. Psychol Sci. 2013; 24(7):1123–1132. [PubMed: 23649562]

Krijthe BP, Walter S, Newson RS, Hofman A, Hunink MG, Tiemeier H. Is positive affect associated with survival? A population-based study of elderly persons. Am J Epi. 2011; 173(11):1298–1307.

Lazo M, Gange SJ, Wilson TE, Anastos K, Ostrow DG, Witt MD, Jacobson LP. Patterns and predictors of changes in adherence to highly active antiretroviral therapy: longitudinal study of men and women. Clin Infect Dis. 2007; 45(10):1377–1385. [PubMed: 17968839]

Logie C, Gadalla TM. Meta-analysis of health and demographic correlates of stigma towards people living with HIV. AIDS Care. 2009; 21(6):742–753. [PubMed: 19806490]

Lyketsos CG, Hoover DR, Guccione M. Depression and survival among HIV-infected persons. JAMA. 1996; 275(1):35–36.

Lyketsos CG, Hoover DR, Guccione M, Senterfitt W, Dew MA, Wesch J, et al. Morgenstern H. Depressive symptoms as predictors of medical outcomes in HIV infection. Multicenter AIDS Cohort Study. JAMA. 1993; 270(21):2563–2567. [PubMed: 7901432]

Magnus M, Schmidt N, Kirkhart K, Schieffelin C, Fuchs N, Brown B, Kissinger PJ. Association between ancillary services and clinical and behavioral outcomes among HIV-infected women. AIDS Patient Care STDS. 2001; 15(3):137–145. [PubMed: 11313026]

Mancuso CA, Choi TN, Westermann H, Wenderoth S, Hollenberg JP, Wells MT, et al. Charlson ME. Increasing physical activity in patients with asthma through positive affect and self-affirmation: a randomized trial. Arch Intern Med. 2012; 172(4):337–343. [PubMed: 22269593]

McLellan AT, Kushner H, Metzger D, Peters R, Smith I, Grissom G, et al. Argeriou M. The 5th edition of the Addiction Severity Index. J Subst Abuse Treat. 1992; 9(3):199–213. [PubMed: 1334156]

McLellan AT, Luborsky L, Cacciola J, Griffith J, Evans F, Barr HL, O'Brien CP. New data from the Addiction Severity Index: Reliability and validity in three centers. J Nerv Ment Dis. 1985; 173(7): 412–423. [PubMed: 4009158]

Meyer JP, Springer SA, Altice FL. Substance abuse, violence, and HIV in women: A literature review of the syndemic. J Womens Health. 2011; 20(7):991–1006.

Middleton R, Byrd E. Psychosocial factors and hospital readmission status of older persons with cardiovascular disease. Journal of Applied Rehabilitation Counseling. 1996; 27(4):3–10.

Moskowitz JT. Positive affect predicts lower risk of AIDS mortality. Psychosom Med. 2003; 65(4): 620–626. [PubMed: 12883113]

Nanni MG, Caruso R, Mitchell AJ, Meggiolaro E, Grassi L. Depression in HIV infected patients: A review. Curr Psychiatry Rep. 2015; 17(1):530. [PubMed: 25413636]

Ogedegbe GO, Boutin-Foster C, Wells MT, Allegrante JP, Isen AM, Jobe JB, Charlson ME. A randomized controlled trial of positive-affect intervention and medication adherence in hypertensive African Americans. Arch Intern Med. 2012; 172(4):322–326. [PubMed: 22269592]

Ostir GV, Markides KS, Peek MK, Goodwin JS. The association between emotional well-being and the incidence of stroke in older adults. Psychosom Med. 2001; 63(2):210–215. [PubMed: 11292267]

Ostir GV, Ottenbacher KJ, Markides KS. Onset of frailty in older adults and the protective role of positive affect. Psychol Aging. 2004; 19(3):402–408. [PubMed: 15382991]

Park-Lee E, Fredman L, Hochberg M, Faulkner K. Positive affect and incidence of frailty in elderly women caregivers and noncaregivers: results of Caregiver-Study of Osteoporotic Fractures. J Am Geriatr Soc. 2009; 57(4):627–633. [PubMed: 19392954]

Peterson JC, Charlson ME, Hoffman Z, Wells MT, Wong SC, Hollenberg JP, et al. Allegrante JP. A randomized controlled trial of positive-affect induction to promote physical activity after

percutaneous coronary intervention. Arch Intern Med. 2012; 172(4):329–336. [PubMed: 22269589]

Polk DE, Cohen S, Doyle WJ, Skoner DP, Kirschbaum C. State and trait affect as predictors of salivary cortisol in healthy adults. Psychoneuroendocrinology. 2005; 30(3):261–272. [PubMed: 15511600]

Radloff L. The CES-D scale: A self-report depression scale for research in the general population. Applied Psychological Measurement. 1977; 1:385–401.

Salovey P, Rothman AJ, Detweiler JB, Steward WT. Emotional states and physical health. American Psychologist. 2000; 55(1):110–121. [PubMed: 11392855]

Schwarzer R, Leppin A. Social support and health: A theoretical and empirical overview. Journal of Social and Personal Relationships. 1991; 8(1):99–127.

Segerstrom SC, Sephton SE. Optimistic expectancies and cell-mediated immunity: the role of positive affect. Psychol Sci. 2010; 21(3):448–455. [PubMed: 20424083]

Shafer AB. Meta-analysis of the factor structures of four depression questionnaires: Beck, CES-D, Hamilton, and Zung. J Clin Psychol. 2006; 62(1):123–146. [PubMed: 16287149]

Sheldon KM, Lyubomirsky S. How to increase and sustain positive emotion: The effects of expressing gratitude and visualizing best possible selves. The Journal of Positive Psychology. 2006; 1(2):73–82.

Sin NL, Lyubomirsky S. Enhancing well-being and alleviating depressive symptoms with positive psychology interventions: a practice-friendly meta-analysis. J Clin Psychol. 2009; 65(5):467–487. [PubMed: 19301241]

Sin NL, Moskowitz JT, Whooley MA. Positive affect and health behaviors across 5 years in patients with coronary heart disease: the heart and soul study. Psychosomatic Medicine. 2015; 77(9):1058–1066. [PubMed: 26428445]

Steptoe A, Dockray S, Wardle J. Positive affect and psychobiological processes relevant to health. J Pers. 2009; 77(6):1747–1776. [PubMed: 19796062]

Steptoe A, Wardle J. Positive affect measured using ecological momentary assessment and survival in older men and women. Proc Natl Acad Sci U S A. 2011; 108(45):18244–18248. [PubMed: 22042845]

Steptoe A, Wardle J, Marmot M. Positive affect and health-related neuroendocrine, cardiovascular, and inflammatory processes. Proc Natl Acad Sci U S A. 2005; 102(18):6508–6512. [PubMed: 15840727]

Tay L, Tan K, Diener E, Gonzalez E. Social relations, health behaviors, and health outcomes: A survey and synthesis. Applied Psychology: Health and Well-Being. 2013; 5(1):28–78. [PubMed: 23281315]

Thomas JL, Jones GN, Scarinci IC, Mehan DJ, Brantley PJ. The utility of the CES-D as a depression screening measure among low-income women attending primary care clinics. The Center for Epidemiologic Studies-Depression. Int J Psychiatry Med. 2001; 31(1):25–40. [PubMed: 11529389]

Vanable PA, Carey MP, Blair DC, Littlewood RA. Impact of HIV-related stigma on health behaviors and psychological adjustment among HIV-positive men and women. AIDS Behav. 2006; 10(5): 473–482. [PubMed: 16604295]

Watson D, Clark LA, Tellegen A. Development and validation of brief measures of positive and negative affect: The PANAS scales. J Pers Soc Psychol. 1988; 54(6):1063–1070. [PubMed: 3397865]

Williams CD, Taylor TR, Makambi K, Harrell J, Palmer JR, Rosenberg L, Adams-Campbell LL. CES-D four-factor structure is confirmed, but not invariant, in a large cohort of African American women. Psychiatry Research. 2007; 150(2):173–180. [PubMed: 17291596]

Wilson TE, Barron Y, Cohen M, Richardson J, Greenblatt R, Sacks HS, Young M. Adherence to antiretroviral therapy and its association with sexual behavior in a national sample of women with human immunodeficiency virus. Clin Infect Dis. 2002; 34(4):529–534. [PubMed: 11797182]

Yehia BR, Stephens-Shields AJ, Fleishman JA, Berry SA, Agwu AL, Metlay JP, et al. Gebo KA. The HIV Care Continuum: Changes over time in retention in care and viral suppression. PLoS One. 2015; 10(6):e0129376. [PubMed: 26086089]

Table 1

Characteristics of women with HIV-infection on ART, by positive affect (waves 1 and 2) and by viral load suppression (wave 3) [1-2]

	Low Positive Affect (N = 634)	High Positive Affect (N = 361)	Test statistic	p-value	Viral load not suppressed (N = 190)	Viral load suppressed (N = 801)	Test statistic	p-value
Age (%)								
Below 35	7.4	6.1	χ^2 (3) = 1.4	0.70	9.9	6.2	χ^2 (3) = 13.7	0.003
35-44	29.8	29.1			38.0	27.5		
45-54	44.3	43.8			35.9	46.1		
Above 55	18.5	21.1			16.2	20.2		
Race / Ethnicity (%)								
White, not Hispanic	10.4	11.9	χ^2 (3) = 0.9	0.82	12.5	10.6	χ^2 (3) = 3.4	0.34
Black, not Hispanic	58.5	56.8			58.9	57.7		
Hispanic	27.6	27.1			23.4	28.4		
Other	3.5	4.2			5.2	3.4		
Recruitment site (%)								
Site A	12.6	25.5	χ^2 (5) = 35.5	< 0.001	19.3	16.8	χ^2 (5) = 40.7	< 0.001
Site B	20.0	20.8			15.1	21.5		
Site C	13.6	13.6			7.3	15.1		
Site D	17.2	17.2			13.5	18.1		
Site E	18.0	11.4			29.2	12.3		
Site F	18.6	11.6			15.6	16.2		
Enrollment cohort (%)								
1994-1995	50.2	53.7	χ^2 (2) = 8.4	0.02	49.5	51.9	χ^2 (2) = 1.1	0.59
2001-2002	32.2	35.5			36.5	32.6		
2011-2012	17.7	10.8			14.1	15.4		
Foreign born (%)	24.1	25.5	χ^2 (1) = 0.2	0.63	15.6	26.8	χ^2 (1) = 10.4	0.001
Spanish interview (%)	11.8	14.7	χ^2 (1) = 1.7	0.20	12.50	13.0	χ^2 (1) = 0.03	0.87
Married or living with partner (%)	29.3	35.7	χ^2 (1) = 4.3	0.04	26.0	33.0	χ^2 (1) = 3.5	0.07
Substance use (%)	9.6	3.6	χ^2 (1) = 12.1	< 0.001	11.5	6.5	χ^2 (1) = 5.6	0.02
Heavy drinking (%)	12.9	12.2	χ^2 (1) = 0.1	0.73	16.7	11.7	χ^2 (1) = 3.5	0.07
Interpersonal difficulties (%)	52.5	14.7	χ^2 (1) = 138.7	< 0.001	43.8	37.6	χ^2 (1) = 2.5	0.12

	Low Positive Affect (N = 634)	High Positive Affect (N = 361)	Test statistic	p-value	Viral load not suppressed (N = 190)	Viral load suppressed (N = 801)	Test statistic	p-value
Mean negative affect (SD)[3]	5.1 (4.4)	0.9 (1.6)	t (869.6) = 22.1	<0.001	4.6 (4.6)	3.4 (4.0)	t (993) = 3.6	<0.001
Mean somatic disturbances (SD)[3]	6.3 (4.0)	2.7 (2.5)	t (986.2) = 18.0	<0.001	6.2 (4.1)	4.7 (3.8)	t (993) = 4.8	<0.001
Suppressed viral load (%)	73.8	82.8	χ^2 (1) = 10.6	0.001	39.0	86.1	χ^2 (1) = 193.7	<0.001
Adherent to ART (%)	80.9	87.8	χ^2 (1) = 7.9	0.005	67.7	87.2	χ^2 (1) = 42.4	<0.001

Notes:

[1] Wave 1 values included for age, race and ethnicity, recruitment site, enrollment cohort, country of birth, interview language, relationship status, and viral suppression; wave 2 values for ART adherence; waves 1 and 2 values for substance use, heavy drinking, interpersonal problems, negative affect, and somatic burden.

[2] Percentages may not add to 100 due to rounding.

[3] Odds ratio for 1-point increase; higher scores denote greater negative affect, more somatic disturbances.