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Stress Management Interventions for HIV+ Adults: A Meta-Analysis of Randomized Controlled Trials, 1989 to 2006

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Abstract

Objective: Numerous studies document that stress accelerates disease processes in a variety of diseases including HIV. As a result, investigators have developed and evaluated interventions to reduce stress as a means to improve health among persons living with HIV. Therefore, the current meta-analysis examines the impact of stress-management interventions at improving psychological, immunological, hormonal, and other behavioral health outcomes among HIV+ adults.

Design—This meta-analytic review integrated the results of 35 randomized controlled trials examining the efficacy of 46 separate stress-management interventions for HIV+ adults ($N = 3,077$).

Main Outcome Measures—Effect sizes were calculated for stress processes (coping and social support), psychological/psychosocial (anxiety, depression, distress, and quality of life), immunological (CD4+ counts and viral load), hormonal (cortisol, dehydroepiandrosterone sulfate [DHEA-S], cortisol/DHEA-S ratio, and testosterone) and other behavioral health outcomes (fatigue).

Results—Compared to controls, stress-management interventions reduce anxiety, depression, distress, and fatigue and improve quality of life ($d_{+s} = 0.16$ to 0.38). Stress-management interventions do not appear to improve CD4+ counts, viral load, or hormonal outcomes compared with controls.

Conclusion—Overall, stress-management interventions for HIV+ adults significantly improve mental health and quality of life but do not alter immunological or hormonal processes. The absence of immunological or hormonal benefits may reflect the studies' limited assessment period (measured typically within 1-week post-intervention), participants' advanced stage of HIV (HIV+ status known for an average of 5 years), and/or sample characteristics (predominately male and Caucasian participants). Future research might test these hypotheses and refine our understanding of stress processes and their amelioration.

Keywords

stress; anxiety; depression; immunological; HIV; meta-analysis

Worldwide, an estimated 39.5 million people were living with HIV including 4.3 million people newly infected in 2006 (UNAIDS, 2006). Although once thought of as an imminently fatal disease, advances in treatment have resulted in increased longevity among people infected with HIV. Coping with a chronic, life-threatening disease, however, is not without consequence as disease progression often involves a series of psychological and physical stressors that may impair daily functioning and quality of life. These stressors may involve a variety of physical symptoms, pain, concerns over disclosure of and stigma associated with HIV, and distress regarding one's own mortality (Derlega, Winstead, Greene, Serovich, & Elwood, 2002; Kalichman & Catz, 2000).

Research has demonstrated that such psychological and physical stressors can alter physiological processes and undermine health (see Kemeny, 2003; McEwen, 1998; Tosevski & Milovancevic, 2006; Vanable, Carey, Blair, & Littlewood, 2006). Although acute activation of these physiological processes is adaptive, chronic activation may lead to negative health effects including impaired immune functioning (see Segerstrom and Miller, 2004). Indeed, increased stress associated with chronic medical diseases such as HIV/AIDS appears to accelerate immune impairment, including reduced lymphocyte circulation and increased cortisol levels and a more rapid progression to AIDS (e.g., Evans et al., 1997; Kemeny & Dean, 1995; Leserman et al., 1999). As a result, health care providers and researchers have developed stress management interventions aimed at reducing overall distress, improving adjustment and disease management, and slowing disease progression.

Stress management interventions have been evaluated using psychological and social outcomes (e.g., depression, social support), immune markers (e.g., CD4+ counts), hormone levels (e.g., cortisol), and other behavioral health outcomes (e.g., fatigue) (for qualitative reviews see Antoni, 2000; Antoni, Ironson, & Lutgendorf, 2000; Chesney & Folkman, 1994; Ironson et al., 2002). As Ironson and colleagues (2002) note in their review, stress management interventions tend to improve psychosocial outcomes but the effects on immune functioning have been inconsistent. For example, some investigators have found improvements in immunological markers such as CD4+ counts for intervention but not control participants (Antoni et al., 1991) whereas other investigators have found similar increases in CD4+ counts for *both* the intervention and control groups (Mulder et al., 1995). In addition, the association between stressful life events and CD4+ counts among people with HIV tends to be delayed. For example, Kemeny and colleagues (1995) found no difference in CD4+ counts among bereaved HIV+ men a year after the loss of an HIV-infected partner compared to non-bereaved HIV+ men. At 3- to 4-year follow-up, the bereaved men showed a more rapid loss of CD4+ cells even after controlling for demographics, health status, use of antiretroviral medications, and substance use compared with the non-bereaved men (Kemeny & Dean, 1995). Examining the relations between psychological variables and HIV disease progression, Kennedy (2000) also found conflicting results and suggested these inconsistencies could be attributed (at least partially) to participants' disease stage (e.g., asymptomatic vs. symptomatic), length of follow-up, and sample characteristics (i.e., gender and sexual orientation). To clarify the ambiguities in the literature, the current meta-analysis will examine the stress management intervention literature for HIV positive adults.

Efficacy of stress management interventions was determined using effect size estimates. We examined the extent to which stress management interventions affect (a) stress processes (coping, social support), (b) psychosocial outcomes (anxiety, depression, distress, quality of life), (c) immunological markers (CD4+ counts, viral load), (d) hormonal levels (urinary cortisol, testosterone), and (e) other related health outcomes (fatigue). As shown in Figure 1, selection of outcomes was guided by the psychoneuroimmunology (PNI) perspective (see Antoni, 2003; Robinson, Mathews, & Witek-Janusek, 2000). According to this view, stress management interventions lead to positive changes in stress processes and psychological

functioning (e.g., improved quality of life, reduced anxiety), complemented by a normalization of the autonomic nervous system (specifically the sympathetic nervous system) and hypothalamic-pituitary-adrenal (HPA) axis as evidenced by reduced secretion of cortisol and catecholamines. HPA normalization may also stabilize testosterone and DHEA-S levels. Faster disease progression has been attributed to lower than normal levels of testosterone or DHEA-S, although these results have been mixed (see Christeff et al., 1996; Ferrando, Rabkin, & Poretsky, 1999). It is hypothesized that these hormonal changes lead to improved immune functioning (e.g., higher CD4+ counts) and consequently slower HIV disease progression. Stress management programs may also impact behavioral outcomes that slow disease progression.

Our overall goals are to resolve inconsistent findings, examine moderators of intervention efficacy, and assist interventionists in developing more efficacious programs for people living with HIV. We use meta-analytic techniques to examine the efficacy of stress management interventions for adults living with HIV/AIDS. Psychosocial, behavioral, and educational stress management interventions were located through a systematic review of the literature. Interventions focusing on stress management or examining a stress management component in a comprehensive program were included. For this review, stress management was defined as any method such as cognitive restructuring, social support training, or mindfulness meditation used to assist with coping and/or managing stress among people living with HIV (see Lichtenthal, Simpson, & Cruess, 2005 for a list of frequently used stress management techniques). Consistent with the PNI perspective, we expected HIV+ adults exposed to a stress management intervention would show improvements in stress processes and psychosocial outcomes and that these improvements could lead to more favorable immunological and hormonal outcomes compared with controls.

Method

Search Strategy

We used several strategies to search for relevant randomized controlled trials (RCTs) meeting our inclusion criteria. Our search included: (a) electronic reference databases (PubMed, PsycINFO, AIDSearch, Dissertation Abstracts, ERIC, CRISP, and the Cochrane Library) using a Boolean search strategy for abbreviated and full keywords (*stress AND (HIV OR AIDS) NOT (children OR adolescent*) AND (intervention OR prevention)*); (b) reference sections of relevant review or published studies; and (c) sending requests for published or unpublished papers to authors and professional listserves (e.g., *American Psychological Association, Division 38*). Unpublished papers (e.g., dissertations or conference reports) were included to avoid the file-drawer effect (i.e., stronger effects reported in published vs. unpublished studies; Rosenthal, 1979).

Study Selection

Studies were included if they (a) examined any psychosocial, behavioral, or educational stress management intervention; (b) sampled only HIV-seropositive adult samples or separated outcomes based on HIV status; (c) used a RCT design; (d) assessed at least one psychological/psychosocial (e.g., depression, coping) process; and (e) provided sufficient information to calculate between-group effect size estimates. Consistent with these criteria, studies were excluded if the interventions did not specifically focus on stress management or provided insufficient details about the stress management component (e.g., stated that stress management techniques were used but offered no information regarding the content), tested the effects of stress-reduction medications, did not report any psychological/psychosocial outcomes, failed to include a comparison condition, or provided insufficient statistical information to calculate effect sizes. When authors did not report sufficient study or statistical

details, we contacted them for additional information. Of the 17 authors contacted, 85% responded resulting in the retention of 14 studies and exclusion of 3 studies (one because the data were no longer available and two because the authors did not provide the necessary information by February 28, 2007).

Studies that fulfilled the search criteria and were available by February 28, 2007 were included. When several publications provided information about a single study (e.g., one paper on methodological details, one referring to the first follow-up results, and a third with 12-month outcomes; see Appendix 1), study characteristics were coded based on the multiple reports and effect sizes were calculated separately for each measurement occasion (due to the small number of studies with multiple follow-ups, we focused on the first measurement occasion only). When more than one control or comparison condition was used (e.g., standard of care and wait-list), the control condition with the least contact (e.g., wait-list) was used as the comparison condition for ease of interpretation of treatment effects. Using these criteria, 35 RCTs, with 46 separate interventions (*k*), qualified for the meta-analysis (see Appendix 3, Figure 3.1). These studies sampled 3,077 adults with HIV with a retention rate of 80% at follow-up (based on the largest available *n* at any follow-up).

Study Outcomes

For each study, effect size estimates were calculated from the information provided in the study or in a related study (i.e., when study outcomes were reported in multiple papers). Effect sizes were calculated for stress processes, psychological/psychosocial, immunological, hormonal, and other behavioral health outcomes. Specifically, the *stress processes* outcomes included: (a) coping and (b) social support; the *psychological/psychosocial* outcomes included: (a) anxiety, (b) depression, (c) distress (general and HIV-specific), and (d) quality of life (general and HIV-specific); the *immunological* outcomes included: (a) CD4+ counts and (b) viral load; the *hormonal* outcomes included: (a) cortisol, (b) dehydroepiandrosterone sulfate (DHEA-S), (c) cortisol/DHEA-S ratio, and (d) testosterone; and the *other behavioral* health outcomes included fatigue.

Effect Size Derivation

Effect sizes (*d*) were calculated as the mean differences between the intervention and control group divided by the pooled posttest standard deviation (Cohen, 1988). If the pooled *SD* was unavailable or could not be derived from the reported statistics, the denominator was replaced with another form of *SD* (e.g., pretest *SD*; Lipsey & Wilson, 2001). When means and standard deviations were unavailable, other statistical information (e.g., *t*- or *F*-values) was used to calculate *d* (Johnson & Eagly, 2000; Lipsey & Wilson, 2001). If a study reported dichotomous outcomes (e.g., frequencies), we calculated an odds ratio and transformed the odds ratios to *d* using the Cox transformation (Sanchez-Meca, Marin-Martinez, & Chacon-Moscoso, 2003). If no statistical information was available (and could not be obtained from the authors) and the study reported no significant between-group differences, we estimated that effect size to be zero (Lipsey & Wilson, 2001). In calculating *d*, we controlled for baseline (if significant baseline differences between the intervention and control condition were found) when pre-intervention measures were reported. A positive sign indicated greater health benefit (e.g., reduced depression) among participants in the intervention condition vs. controls; effect sizes were corrected for sample size bias (Hedges, 1981). DSTAT 2.0 (Johnson & Wood, 2006) was used to calculate effect sizes.

We calculated multiple effect sizes from individual studies when they had more than one outcome of interest, multiple intervention conditions, or when outcomes were separated by sample characteristics (e.g., gender). When a study contained multiple measures of the same outcome (e.g., depression measured using the Beck Depression Inventory and the Hamilton

Depression Rating Scale), the effect sizes were averaged. Effect sizes calculated for each intervention and by sample (e.g., when studies separated outcomes by gender) were analyzed as separate interventions. Of the 35 RCTs included in the meta-analysis, 46 separate interventions were evaluated.

Coding and Reliability

Two researchers independently coded study information (e.g., theory used to guide intervention), sample characteristics (e.g., ethnicity, gender, age), risk characteristics (e.g., current alcohol or drug use), design and measurement specifics (e.g., number of follow-ups), and content of intervention and control condition(s) (e.g., number of sessions, specific content of the intervention). Twenty studies were randomly selected to examine reliability. For the categorical dimensions, raters agreed on 62% to 100% of the judgments (mean Cohen's $\kappa = .70$). Reliability for the continuous variables was calculated using the intraclass correlation coefficient (ρ); ρ ranged from .50 to 1.00, with an average $\rho = .96$ across categories. Coding disagreements were resolved through discussion.

Statistical Analysis

We first examined each set of effect sizes (i.e., for each dependent variable) for extreme outliers resulting in the exclusion of 8 out of 156 effect sizes where $k \geq 5$ (see Table 1)¹. After excluding the outliers, weighted mean effect sizes, d_+ s, were calculated using fixed- and random-effects procedures (Lipsey & Wilson, 2001), such that individual studies' effect sizes were weighted by the inverse of their fixed or random variance. The homogeneity statistic, Q , was computed to determine whether each set of d_+ s shared a common effect size. The homogeneity of variance statistic has an approximate chi-square distribution with the number of effect sizes (k) minus 1 degrees of freedom (Hedges & Olkin, 1985). To further assess heterogeneity, the I^2 index was calculated to assess the proportion of total variability in a set of effect sizes attributable to true heterogeneity (Higgins & Thompson, 2002; Huendo-Mendina, Sanchez-Meca, Marin-Martinez, & Botella, 2006). Percentages of 25%, 50%, and 75%, are considered low, medium, and high heterogeneity respectively (Higgins, Thompson, Deeks, & Altman, 2003). If the 95% uncertainty interval around the I^2 index includes a zero, the set of effect sizes are homogeneous. If Q remained significant after the exclusion of outliers and the I^2 index (and corresponding 95% uncertainty interval) indicated that a medium-to-large amount of between-studies variability could be explained, the relation between study characteristics and the magnitude of the effects were examined. Modified least squares regression analyses were used to determine the relation between study characteristics and the magnitude of effect sizes. All analyses were conducted in Stata 10.0 (StataCorp, 2007) using macros provided by Lipsey and Wilson (2001) except for the I^2 index and corresponding 95% uncertainty intervals which were calculated using formulas provided by Higgins & Thompson (2002).

Results

Description of Studies

A descriptive summary of the 35 studies is found in Table B1. The studies appeared between 1989 and 2006, all were written in English, and 31 (89%) were published in journals. Most of the studies ($k = 24$; 69%) stated they used behavioral science theory to guide their intervention design; 15 studies (63%) used more than one theoretical perspectives. Studies were

¹Although there are no formal guidelines regarding the minimum number of effect sizes necessary to calculate weighted mean effect sizes, outcomes with fewer than five interventions are not reported due to potential interpretation bias from a single intervention. Therefore, we were unable to examine the following additional *other behavioral* health outcomes: medication adherence ($k = 3$), disruptive or problematic sleep ($k = 2$), condom use ($k = 3$), sexual frequency ($k = 1$), number of sexual partners ($k = 1$), alcohol use ($k = 2$), and drug use ($k = 1$). None of the weighted mean effect sizes (when $k \geq 2$) were significant.

predominately (77%) conducted in the U. S. and in clinical (59%) or community/home settings (41%). Participants were typically recruited through clinical contact (46%) or a combination of clinical or community (e.g., flyers, newspaper advertisements) contact (43%). All studies randomly assigned participants or groups (e.g., clinic patients) to conditions and evaluated participants at both pre- and post-test. The median number of post-intervention follow-ups was one, with a mean of 1.57 ($SD = 0.81$) follow-ups after baseline data collection (range = 1 to 4 assessments). The first post-intervention assessment period (the focus of this review) occurred an average of 1.16 ($SD = 4.36$; range = 0 to 26, $Mdn = 0$) weeks after the intervention.

Description of Samples

Study participants were predominately male (82%; $k = 33$), white (56%; $k = 30$), and 37.47 ($SD = 3.58$; range = 28.51 to 45.25; $k = 32$) years of age. Of the 22 studies reporting time elapse since HIV diagnosis, the average number of months participants had been living with HIV was 60.44 ($SD = 27.37$; range = 0 to 117.60). Antiretroviral medication use was reported in 86% ($k = 30$) of the studies (9 of these studies excluded participants based on antiretroviral use); 51% ($k = 23$) of the participants were taking antiretroviral medications. Few studies (34%) reported clinical depression (4 studies included and 8 studies excluded participants based on a clinical depression screen); 7% of the sample were clinically depressed ($k = 11$). Of the 7 studies reporting the proportion of participants experiencing anxiety, 17% of participants met criteria for the diagnosis of an anxiety disorder (using a clinical interview) or exceeded a suggested cut-point on a self-report measure of anxiety. Several studies ($k = 10$) reported sampling distressed participants; 2 studies excluded participants experiencing distress whereas 23 studies did not report distress levels of their samples. For studies reporting sexual activity ($k = 12$) and sexual orientation ($k = 18$), 72% of participants were sexually active and 67% of participants were men who have sex with men (MSM). Most participants (83%; $k = 20$) were not using illegal drugs and 97% ($k = 31$) had not been diagnosed or treated for a serious mental disorder.

Description of Intervention and Control Conditions

Of the 35 studies included in the meta-analysis, 46 separate treatment conditions were evaluated as some studies reported on more than one active intervention or subsample. Interventions were conducted in small groups (64%) or one-on-one (36%); small group interventions consisted of a median of 10 sessions of 90 minutes and tended to have a median of 2 facilitators and 8 participants whereas one-on-one interventions consisted of a median of 16 sessions of 49 minutes each. Interventions frequently included coping skills (59%), intrapersonal skills training (e.g., planning of stress management; information-only or actively practiced; 50%), and active practice of mental and/or physical relaxation exercises (48%); they often included HIV/AIDS education (including rationale for stress management; 37%), social support (37%), and exercise education, planning, or practice (26%). Interventions infrequently included medication adherence (13%) or nutritional education, planning, or practice (7%), relaxation exercise information (discussed or demonstrated but not practiced; 11%), or spirituality (4%). Supplemental materials (e.g., brochures, guided relaxation audiocassettes) were provided in 33% of the interventions. Intervention content was frequently tailored to the group (37%) or individual (22%) with 37% of facilitators matched to the participant(s) on some characteristic (gender, race, HIV status, sexual orientation, or age). Of the 35 interventions reporting details about the intervention leaders, 71% used professionals-in-training (e.g., clinical graduate students) and/or professionals (terminal professional degree, e.g., PhD).

The most typical comparison condition, used by 74% of investigators, was an assessment-only control (i.e., no explicit stress management treatment or wait-listed). Of the 12 interventions using a more active comparison conditions (e.g., education-only, brief form of intervention), these interventions were characterized by a median of 8 sessions of 75 minutes each with a

median of 1 facilitator and 4.25 participants. Supplemental materials (e.g., brochures, relaxation exercises) were provided in 17% of the active comparisons conditions.

Intervention Impact

As detailed in Table 1, stress management interventions reduced anxiety ($d_+ = 0.28$, 95% CI 0.17, 0.40), depression ($d_+ = 0.28$, 95% CI 0.19, 0.37; see Figure 2), psychological distress ($d_+ = 0.19$, 95% CI 0.06, 0.33), and fatigue ($d_+ = 0.38$, 95% CI 0.16, 0.59) and improved quality of life ($d_+ = 0.16$, 95% CI 0.05, 0.27) relative to controls (see Appendix 3 for remaining figures).² There were no improvements observed on the other variables assessed at first measurement occasion (i.e., coping, social support, CD4+ count [see Figure 3]³, viral load, or hormonal outcomes). These effects were parallel using either fixed- or random-effects assumptions. All of the effects were homogeneous except for anxiety, $Q(21) = 39.77$, $p = .001$; examination of the I^2 index confirmed moderate levels of heterogeneity (53%). Because the weighted mean effect sizes cannot adequately describe the variability in the effectiveness of stress management intervention at reducing anxiety (as evidenced by the Q and I^2 index), moderator tests were conducted.

Moderators of intervention impact on anxiety—Potential moderators of the impact of the intervention on anxiety were examined using regression analysis. We entered demographic (gender, ethnicity, age) and sample characteristics (months since HIV diagnosis, proportion sexual active, proportion MSM, proportion taking antiretroviral medications, proportion clinically depressed, proportion anxious, proportion distressed) as individual predictors of anxiety. Analyses showed that interventions were *more* successful at improving anxiety when they included more women ($\beta = 0.37$, $p = .02$) and/or sampled more participants who were anxious at baseline ($\beta = 0.54$, $p < .01$) but were *less* successful when they included older participants ($\beta = -0.35$, $p = .03$). We then entered intervention details (dosage, tailored content) and content (e.g., coping skills, active practice of mental and/or physical relaxation exercises) as individual moderators of the intervention impact on anxiety. Interventions were *less* successful at improving anxiety when they included more medication adherence information and/or planning ($\beta = -0.53$, $p < .001$). When significant univariate moderators were considered simultaneously in a multiple regression model, the only significant predictor of anxiety was medication adherence information and/or planning ($\beta = -0.36$, $p = .04$); interventions including medication adherence information and/or planning were *less* efficacious at improving anxiety. Model fit was excellent, $Q_{\text{Residual}}(17) = 21.70$, $p = .20$, suggesting that the unexplained variability in effect sizes is no greater than expected from sampling error.

Discussion

In our meta-analytic review, stress management interventions for adults living with HIV infection were found effective in reducing emotional distress including anxiety, depression, and psychological distress. These interventions also reduced fatigue and improved quality of life. The effect sizes we observed were in the small to medium range, consistent with effects

²Subsequent analyses (calculating the between-groups-of-studies measure, Q_B , which is the weighed sum of squares of group mean effect sizes about the grand mean effect size [Hedges, 1994]), examined the weighted mean effect sizes by type of control condition (active comparison vs. no treatment control). There were no differences by type of control condition for any of our dependent variables except for anxiety and depression. Stress management interventions were more successful in improving anxiety, $Q_B(1) = 6.05$, $p = .01$, and depression, $Q_B(1) = 4.83$, $p = .03$, when compared to a no treatment control than an active comparison condition.

³Prior research has shown the benefit of initiating ART on increasing CD4+ counts and viral load. To examine these differences in CD4+ counts among studies sampling participants using and not using ART, we calculated the between-groups-of-studies measure, Q_B . There were no differences between groups on CD4+ counts, $Q_B(1) = 0.87$, $p = .35$. Stress management interventions were no more efficacious at improving CD4+ counts when sampling participants using ART ($k = 13$), $d_+ = 0.03$ (95% CI -0.15 , 0.21), than when they sampled participants not using ART ($k = 5$), $d_+ = 0.20$ (95% CI -0.14 , 0.53) compared to controls. None of the studies measuring viral load sampled participants who were not using ART.

found for stress management interventions (i.e., mindfulness-based) in cancer, heart disease, and other chronic illnesses (Grossman, Niemann, Schmidt, & Walach, 2004).

Follow-up analyses indicated that most observed effects were homogeneous. In contrast to this general pattern, the effects for anxiety were heterogeneous, meaning that variations in efficacy might be explained by characteristics of the intervention, recipient, or study. For anxiety outcomes, we found that reductions in anxiety were adversely related to inclusion of medication adherence information and/or planning in the intervention content. It is important to note that few studies included medication adherence components but, when they did, the anxiety-reducing effects of stress management were lessened. We hypothesize that improving adherence to demanding medication regimens, such as those required in treating HIV infection, requires increased vigilance and may inadvertently elevate anxiety. Indeed, Ammassari and colleagues (2001) find self-reported anxiety symptoms to be significantly related to non-adherence. This is speculative and additional research designed to disentangle the potential interactive effects of anxiety reduction and adherence improvement strategies is warranted.

Lacking from most studies were analyses exploring the mechanism(s) by which the stress management interventions worked. Future research might look to research on the efficacy of cognitive-behavioral interventions for depression and anxiety disorders to better understand how stress management operates. For example, perhaps stress management interventions simply distract patients from the daily burden of living with a serious chronic disease, affording temporary relief from this burden. Alternatively, these interventions may alter appraisal processes or harmful attitudes that typically lead to anxious or depressive cognitions or the interventions may change health behaviors (e.g., physical activity, diet, substance misuse, or sleep) in a way that improves affective outcomes. Exploring the mechanism of action for the beneficial effects will help to streamline stress management interventions by making them more efficient.

To our surprise, we did not find evidence that stress reduction interventions improved immune functioning or hormonal mechanisms that could influence immunity. These findings contrast with the PNI perspective that guided our work and most of the interventions included in our review (Antoni, 2003; Robinson et al., 2000). Thus, even though chronic stressors are known to suppress both cellular and humoral markers (see Segerstrom & Miller, 2004); the short-term use of stress management strategies does not seem to reverse these processes in patients with HIV. Before concluding that stress management interventions are ineffective in improving the immunological health of people living with HIV/AIDS, however, it is appropriate to consider potential alternative explanations for these null effects. For example, it is possible that even the most potent stress management intervention will be unable to overcome the devastating effects of HIV on the immune system. Relevant to this point, participants in the RCTs we reviewed had tested HIV positive more than five years prior to enrollment. Given that many people do not seek HIV testing until infection is well-established, the degree of immune system compromise in these participants may have been well-advanced.

A second possible explanation is the selection of participants using antiretroviral therapies (ART). Numerous studies have documented the benefit of initiating ART on increasing CD4 + counts and reducing viral load (e.g., Cole, Hernan, Anastos, Jamieson, & Robins, 2007; Cole, Hernan, Margolick, Cohen, & Robins, 2005; Yamashita et al., 2001). It is possible that the lack of an effect on CD4+ counts and viral load in our sample of studies was due to the use of ART. Indeed, several authors reported selecting or including participants who were or were not using ART ($k = 30$). Subsequent analyses, however, showed no difference between studies sampling participants using or not using ART (see footnote 3). The same analyses could not be conducted for viral load as none of the studies reporting viral load in our meta-analysis included participants who were not using ART.

A third possible explanation is that cascading of stress reduction effects requires time to influence hormonal and immunologic processes. Thus, it is possible that the immediate effects of these interventions on emotional distress and quality of life may predict clinically meaningful health improvement over time. Unfortunately, few of the RCTs in this literature extended follow-up observations beyond an immediate post-intervention assessment. Fourth, the measurement of immune markers remains an inexact science; thus, while the conceptualization of stress processes may be correct, and the interventions efficacious, the measures may be insufficiently reliable or sensitive. Therefore, we cannot draw definitive conclusions regarding the potential for physiological improvements from stress management interventions for people living with HIV/AIDS. Our review clearly calls for additional trials with longer-term follow-up of immune functioning markers.

In this era of ever-escalating health care costs, an important issue raised by our findings is the degree to which the observed emotional and quality of life benefits justify the costs of the interventions tested. The interventions we reviewed had a median of 10 group sessions or 16 individual counseling sessions, with durations that averaged nearly an hour or longer per session. These interventions were conducted by professionals-in-training, an unlikely scenario outside of academic settings, as well as well-trained (i.e., doctoral level) mental health professionals. The cost of these interventions has not yet been examined in economic analysis. In the absence of evidence for immune system change, some may suggest that these interventions are not cost-effective from a societal perspective. An alternative view is that the benefits of stress management interventions on mental health outcomes are worthwhile, and that these mental health improvements may indirectly promote healthy behavior (e.g., condom use; see Figure 1), potentially reducing the costs associated with acquiring drug-resistant strains of HIV and the transmission of HIV to uninfected partners. Nonetheless, we assert that additional research is necessary to determine the overall cost-effectiveness of stress management interventions. Scientist-practitioners may need to refine interventions to be more powerful and to streamline these interventions so that the improved mental health that results from stress management is maintained while simultaneously reducing their costs. Our findings suggest that such interventions may be most successful when they can improve medication adherence without increasing anxiety. Research should also explore whether stress management interventions can be delivered with fidelity and equivalent outcomes by paraprofessionals; this will increase their versatility, and reduce their cost (Durlak, 1979).

A second issue raised by our review is applicability of stress management interventions for all persons affected by HIV. The majority of participants in the RCTs we studied were men (82%) and Caucasian (56%); only 3% of study participants had a history of severe mental illness. These characteristics contrast with the epidemiology of HIV and AIDS, when people of color, women, those with alcohol and other drug dependencies, the homeless, and the mentally ill are disproportionately vulnerable. So, coupled with the relatively high-cost noted earlier, we are concerned about the ecological value of the interventions tested. Along with research to test enhanced and lower cost interventions, studies are needed to test stress management strategies that can be used in clinical and community services for non-Caucasians and women, including those with histories of mental health and substance abuse problems. Along these same lines, there is no basis for generalizing the stress management interventions tested thus far to developing countries that are home to the vast majority of people living with HIV/AIDS worldwide. Indeed, only a single study included in our meta-analysis was conducted in a developing country (i.e., Brazil). People living with HIV/AIDS in developing countries have demonstrated higher levels of emotional distress, trauma and diminishing quality of life (e.g., Mello & Malbergier, 2006; Kaharuzza et al., 2006; Olley, Zeier, Seedat, & Stein, 2005; Simbayi et al., 2007). Research is needed to examine the efficacy and cost-benefits of stress-reduction interventions that can serve people living with HIV/AIDS at greatest need.

Limitations

Results from this meta-analytic review must be considered in light of its limitations. First, we restricted studies to those that assessed at least one psychosocial outcome. Because our conceptual model (see Figure 1) posited stress management interventions would have the greatest impact on psychosocial outcomes, we sought to include the largest number of studies that would allow us to evaluate this expectation. It is possible that by restricting studies to those reporting at least one psychological outcome may have excluded studies that were successful at improving immunological or hormonal outcomes. Although, changes may have remained undetected given the lengthier intervals that may be required to observe changes in immunological or hormonal outcomes (e.g., Kemeny et al., 1995; Kemeny & Dean, 1995). Related, the studies were limited by the reporting of ART use—with CD4+ counts used as a common measure of antiretroviral efficacy. Inconsistencies in the inclusion/exclusion of samples using ART and the lack of information regarding ART adherence likely obscured any impact of the interventions on CD4+ counts.

Second, few of the RCTs in this meta-analysis had multiple assessment periods and therefore our analyses were limited to the first post-intervention assessment (occurring an average of 1 week after the intervention). As noted earlier, this limitation precluded the examination of the long-term efficacy of stress management interventions and may have concealed positive effects of these interventions on immunological and/or hormonal outcomes.

Third, an implicit assumption of these studies is that people with HIV are experiencing distress. Although research has demonstrated the negative impact of HIV-related stress on mental health (e.g., Lee, Kochman, & Sikkema, 2002; Vanable et al., 2006), it would be mistaken to assume all individuals with HIV experience high levels of distress. Furthermore, some studies reported restricting their samples to those who were or were not experiencing distress while others failed to report baseline distress levels (simply stating that there were no differences between groups on a particular distress measure). It is likely that the intervention impact on individuals experiencing distress would differ from those not distressed. Future studies should explore differences in intervention efficacy among people with varying levels of distress.

Conclusions

Stress management interventions for HIV+ adults improved mental health, quality of life, and fatigue but did not improve stress, immunological, or hormonal outcomes. The absence of immunological or hormonal benefits may reflect the studies' limited assessment period (measured typically within 1-week post-intervention), participants' advanced stage of HIV (HIV+ status known for an average of 5 years), the inclusion/exclusion of participants using ART, the lack of information regarding ART adherence, and/or sample characteristics (predominately male and Caucasian participants). Future investigation should examine more diverse samples, explore patient characteristics that might moderate intervention efficacy, and use lengthier assessment periods to understand better the impact of stress management interventions for HIV+ adults.

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Appendix 1

Supplemental papers (e.g., intervention details, additional measurement occasions) used to code study details and/or effect sizes for the 35 included RCTs (reference paper indicated in brackets).

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Appendix 2

Table B1

Descriptive features of the 35 RCTs included in the meta-analysis.

<u>Citation</u>	<u>Sample</u>	<u>Intervention Details</u>	<u>Stress Processes and Psychological Outcome(s)</u>	<u>Stress Processes and Psychological Measure(s)[†]</u>
Auerbach et al. (1992)	N = 20; 0% F 90% W, 5% B, 5% H	Theory-based, 8-session (ETD = 720 minutes) group intervention emphasizing HIV education (including rationale for stress management) and active practice of mental and physical relaxation exercises. WL/NT control.	Anxiety Depression	POMS POMS, BDI
Bagis et al. (2002)	N = 78; 20% F 56% B, 32% W, 10% H	45-session (ETD = 1800 minutes) individual home-based intervention emphasizing exercise education and practice. WL/NT control.	QOL	MOS-HIV, SIP
Balfour et al. (2006)	N = 63; 18% F 71% W, 17% B HIV: 49.03	Theory-based, 4-session (ETD = 300 minutes) individual intervention emphasizing HIV education (including rationale for stress management), medication adherence, coping skills, intrapersonal skills training, and relaxation strategies (not practiced). WL/NT control.	Depression	CES-D
Birk et al. (2000)	N = 31; 48% F HIV: 63.6	<i>Massage Therapy</i> . 12-session (ETD = 540 minutes) individual intervention emphasizing relaxation exercises. WL/NT control.	QOL	NIAID General Health Self-Assessment form
		<i>Massage Therapy + Exercise</i> . 36-session (ETD = 1320 minutes) individual intervention emphasizing relaxation and aerobic exercise. WL/NT control.		
		<i>Massage Therapy + Stress Management</i> . 24-session (ETD = 1080 minutes) individual intervention emphasizing relaxation exercises (including biofeedback). WL/NT control.		
Borman et al. (2006)	N = 68; 19% F 52% W, 31% B, 15% H HIV: 117.6	Theory-based, 6-session (ETD = 540 minutes) group intervention emphasizing active practice of mental relaxation exercises and spirituality. Time-matched, HIV-education only.	Anxiety Depression Distress QOL	STAI CES-D IES, PSS FACIT, Q-LES-Q
Brazier et al. (2006)	N = 47	27-session group (including 15-day residential program; ETD = 7920 minutes) intervention emphasizing active practice of mental and physical relaxation exercises. WL/NT control.	Anxiety Depression Distress QOL	MHI MHI DSI, MHI MOS-HIV, MHI
Caddick (1994)	N = 19; 16% F 68% W, 21% B, 11% H HIV: 24.32	Theory-based, 6-session (ETD = 540 minutes) group intervention emphasizing HIV education (including rationale for stress management), nutritional education and planning, medication adherence, coping skills, intrapersonal skills training, relaxation exercises (not practiced), and social support. WL/NT control.	Anxiety Depression Distress	HAM-A BDI, HAM-D IES
Carrico et al. (2006) ⁺	N = 98; 0% F 52% W, 21% B, 20% H HIV: 93.6	13-session (ETD = 1470 minutes) group intervention emphasizing medication adherence, coping skills, and active practice of mental and physical relaxation exercises. Brief form of intervention condition.	Coping Anxiety Depression	COPE POMS BDI, POMS
Chan et al. (2005)	N = 13; 0% F 100% A	Theory-based, 7-session (ETD = 840 minutes) group intervention emphasizing HIV education (including rationale for stress management), coping skills, intrapersonal skills training, active practice of mental relaxation exercises, and social support. WL/NT control.	Anxiety Depression	SF-36 CES-D, SF-36

<u>Citation</u>	<u>Sample</u>	<u>Intervention Details</u>	<u>Stress Processes and Psychological Outcome(s)</u>	<u>Stress Processes and Psychological Measure(s)^a</u>
Chesney et al. (2003) ⁺	N = 79; 0% F 82% W	Theory-based, 16-session (ETD = 1440 minutes) group intervention emphasizing coping skills, active practice of intrapersonal skills and physical relaxation exercises, and social support. Education-only control.	Social Support Anxiety Depression Distress Coping SE	SRS STAI CES-D PSS NEW
Côté & Pepler (2002) ⁺	N = 41; 0% F 100% W HIV: 72	Theory-based, 3-session (ETD = 75 minutes) individual intervention emphasizing coping skills and active practice of intrapersonal skills. WL/NT control.	Distress	IES
Danielson (2002)	N = 20; 100% F 67% B, 8% C, 5% H, 3% W HIV: 94.68 months	Theory-based, 10-session (ETD = 1500 minutes) group intervention emphasizing HIV education (including rationale for stress management), medication adherence, coping, active practice of intrapersonal skills, mental and physical relaxation exercises, and social support. Brief form of intervention condition.	Social Support Depression	ESSI, SSSS BDI, CES-D
Eller et al. (1995) ⁺	N = 69; 13% F 61% W, 35% B, 3% H, 1% NA HIV: 41.8	<i>Guided Imagery</i> . Theory-based, 36.48-session (ETD = 784.32 minutes) self-administered intervention emphasizing active practice of mental relaxation. WL/NT control.	Depression QOL	CES-D MOS-HIV, SIP
		<i>Progressive Muscle Relaxation</i> : Theory-based, 30.91-session (ETD = 370.92 minutes) self-administered intervention emphasizing active practice of physical relaxation exercises. WL/NT control.		
Galantino et al. (2005) ⁺	N = 38; 0% F 61% W, 29% B, 10% H	<i>Tai Chi</i> . 16-session (ETD = 960 minutes) group intervention emphasizing active practice of mental and physical relaxation skills. WL/NT control.	Anxiety Depression QOL	POMS POMS MOS-HIV, SWB
		<i>Aerobic Exercise</i> . 16-session (ETD = 960 minutes) group intervention emphasizing exercise education and practice. WL/NT control.		
Gifford et al. (1998)	N = 58; 0% F 76% W, 10% B, 7% H	Theory-based, 7-session (ETD = 960 minutes) group intervention emphasizing HIV/AIDS education (including rationale for stress management), nutrition, exercise, and adherence education and/or planning/practice, coping skills, active intrapersonal skills, and active practice of mental and physical relaxation exercises. WL/NT control.	Depression Distress QOL	CES-D PSS MOS-HIV
Goodkin et al., (1998) ⁺	N = 74; 0% F 53% W, 28% H, 16% B	Theory-based, 10-session (ETD = 900 minutes) group intervention emphasizing coping skills, intrapersonal skills training, spirituality, and social support. WL/NT control.	Anxiety Depression Distress	HAM-A HAM-D POMS TMD
Inouye et al. (2001)	N = 39; 10% F 75% W, 13% A HIV: 70	14-session (ETD = 1050 minutes) individual intervention emphasizing HIV education (including rationale for stress management), coping skills, intrapersonal skills training, and active practice of mental and physical relaxation exercises. WL/NT control.	Coping Social Support Anxiety Depression	JCS JCS POMS POMS
Kalichman (2005) ⁺	N = 271; 30% F 74% B, 22% W HIV: 91.2	Theory-based, 5-session (ETD = 600 minutes) group intervention emphasizing HIV/AIDS education (including rationale for stress management), coping skills, and active practice of intrapersonal skills. Time-matched, relevant content control.	Social Support Depression Distress	Perceived Social Support BDI BSI, NEW
Kelly et al. (1993)	N = 68; 0% F 62% W, 29% B	<i>Cognitive-Behavioral</i> . Theory-based, 8-session (ETD = 720 minutes) group intervention emphasizing coping skills, active practice of mental and physical	Social Support Anxiety Depression	SPS SLC-90-R CES-D, SCL-90-R

<u>Citation</u>	<u>Sample</u>	<u>Intervention Details</u>	<u>Stress Processes and Psychological Outcome(s)</u>	<u>Stress Processes and Psychological Measure(s)^a</u>
		relaxation exercises, and social support. WL/NT control.		
		<i>Social Support</i> . Theory-based, 8-session (ETD = 720 minutes) group intervention emphasizing coping skills and social support. WL/NT control.		
LaPerriere et al. (1990) ⁺	N = 27; 0% F 57% W, 10% B, 33% H HIV: 0	<i>Aerobic Exercise</i> : Theory-based, 30-session (ETD = 1350 minutes) group intervention emphasizing exercise education and practice. WL/NT control.	Anxiety Depression	POMS POMS
		<i>Cognitive Behavioral Stress Management</i> : Theory-based, 20-session (ETD = 1350 minutes) group intervention emphasizing HIV education (including rational for stress management), coping skills, intrapersonal skills training, active practice of mental and physical relaxation exercises, and social support. WL/NT control.		
Letchner et al. (2003) ⁺	N = 330; 100% F 59% B, 16% H, 10% W HIV: 74.4	<i>Cognitive Behavioral Stress Management + Supportive Therapy</i> . Theory-based, 10-session (ETD = 1200 minutes) group intervention emphasizing HIV education (including rational for stress management), coping skills, active practice of intrapersonal skills, active practice of mental and physical relaxation exercises, and social support. Time-matched, relevant-content control.	Depression QOL	BDI MOS-HIV
Lutgendorf et al. (1994) ⁺	N = 141; 0% F 55% W, 33% H, 5% B	Theory-based, 10-session (ETD = 1500 minutes) group intervention emphasizing HIV education (including rational for stress management), coping skills, active practice of intrapersonal skills, mental and physical relaxation, and social support. WL/NT control.		
Markowitz et al., (1998) ⁺	N = 51; 17% F 57% W, 25% H, 16% B HIV: 30.4	<i>Interpersonal Psychotherapy</i> . Theory-based, 16-session (ETD = 800 minutes) individual intervention emphasizing HIV education (including rationale for stress management), coping skills, and active practice of intrapersonal skills. Relevant content, not matched for time.	Depression	BDI, HAM-D
		<i>Cognitive Behavioral Therapy</i> . Theory-based, 16-session (ETD = 800 minutes) individual intervention emphasizing coping skills. Relevant content, not matched for time.		
McCain et al. (2003)	N = 112; 20% F 55% B, 43% W	<i>Cognitive-Behavioral Relaxation Training</i> . Theory-based, 8-session (ETD = 720 minutes) group intervention emphasizing coping skills, active practice of intrapersonal skills, mental, and physical relaxation exercises. WL/NT control.	Coping Social Support Distress QOL	WOC SPS DIS, IES FAHI
		<i>Social Support Groups</i> : Theory-based, 8-session (ETD = 720 minutes) group intervention emphasizing coping skills, active practice of intrapersonal skills, and social support. WL/NT control.		
Miles et al. (2003)	N = 74; 100% F 100% B HIV: 63	Theory-based, 6-session (ETD = 360 minutes) individual intervention emphasizing HIV education, nutrition and exercise education and planning/practice, coping skills, intrapersonal skills training, and social support. WL/NT control.	Anxiety Depression Distress QOL	POMS CES-D, POMS HIV Worry Scale MOS-HIV
Mulder et al. (1994) ⁺	N = 27; 0% F HIV: 60	Theory-based, 16-session (ETD = 2730 minutes) group intervention emphasizing HIV education (including rationale for stress management), exercise education and planning, coping skills, active practice of physical	Coping Social Support Depression Distress	COPE COPE, SSQ BDI POMS-TMD

<u>Citation</u>	<u>Sample</u>	<u>Intervention Details</u>	<u>Stress Processes and Psychological Outcome(s)</u>	<u>Stress Processes and Psychological Measure(s)^a</u>
		relaxation exercises, and social support. Time-matched, relevant-content control.		
Neidig et al. (2003) ⁺	<i>N</i> = 48; 13% 82% W, 18% B HIV: 51.6	36-session (ETD = 2160 minutes) intervention emphasizing exercise education, planning, and practice. WL/NT control.	Depression	BDI, CES-D, POMS
Perry et al. (1991) ⁺	<i>N</i> = 72; 13% F 76% W, 11% B, 9% H, 2% A	Theory-based, 8-session (ETD = 390 minutes) intervention emphasizing HIV education (including rationale for stress management), coping skills, and active practice of intrapersonal skills. Education-only control.	Anxiety Depression	STAI BDI, HAM-D
Schlenzig et al. (1989)	<i>N</i> = 28	16-session (ETD = 960 minutes) intervention emphasizing exercise education and practice. WL/NT control.	Anxiety Depression	POMS POMS
Sikkema et al., (2004) ⁺	<i>N</i> = 235; 35% F 53% B, 28% W, 13% H HIV: 83.4	Theory-based, 12-session (ETD = 1080 minutes) group intervention emphasizing coping skills, active practice of intrapersonal skills, and social support. WL/NT control.	Coping Anxiety Depression QOL	CWI, WOC HAM-A HAM-D FAHI
Stout-Shaffer (1999)	<i>N</i> = 29; 14% F 79% W	Theory-based, 6-session (ETD = 720 minutes) individual intervention emphasizing HIV education (including rationale for stress management) and active practice of mental and physical relaxation exercises. WL/NT control.	Anxiety Depression QOL	POMS POMS MOS-HIV
Stringer et al. (1998)	<i>N</i> = 26; 11% F 51% W, 29% H, 20% B HIV: 39	<i>Moderate Exercise.</i> 18-session (ETD = 1080 minutes) intervention emphasizing exercise education, planning, and practice. WL/NT control.	QOL	QOL
		<i>Heavy Exercise.</i> 18-session (ETD = 630 minutes) intervention emphasizing exercise education, planning, and practice. WL/NT control.		
Taylor (1995)	<i>N</i> = 10; 0% F 100% W HIV: 78	20-session (ETD = 1200 minutes) individual intervention emphasizing active practice of mental and physical relaxation exercises. WL/NT control.	Anxiety Distress	STAI POMS-TMD
Terry et al. (1999)	<i>N</i> = 21; 45% F	36-session (ETD = 2160 minutes) intervention emphasizing exercise education, planning, and practice. Time-matched, relevant content control.	Depression	Montgomery-Åsberg Scale
Weiss et al. (2003)	<i>N</i> = 73; 0% F 97% W HIV: 48	Theory-based, 22-session (ETD = 3300 minutes) group intervention emphasizing HIV education (including rationale for stress management), medication adherence, coping skills, active practice of intrapersonal skills and physical relaxation exercises, and social support. Education-only control.	Coping Social Support Anxiety Depression Distress	COPE SSQ POMS BDI, POMS HSCL, HIV Life Events List

Note. Citations with a plus (+) sign indicate more than one study was used to code the study details and/or the effect sizes. *N*, final *n* not initial *n*; F, female; A, Asian; C, Caribbean; B, Black; H, Hispanic/Latina; NA, Native American; W, White; HIV, length of time in months since HIV diagnosis; ETD, estimated total dosage; WL/NT, wait-list/no treatment control; BDI, Beck Depression Inventory; BSI, Brief Symptom Inventory; CES-D, The Center for Epidemiological Studies-Depression Scale; COPE, Coping Inventory; CWI, Coping with Illness Scale; DSI, Daily Stress Inventory; ESSI, ENRICH Social Support Index; FACIT, Functional Assessment of Chronic Illness Therapy Measurement System; FAHI, Functional Assessment of HIV Infection; HAM-A, Hamilton Anxiety Rating Scale; HAM-D, Hamilton Depression Rating Scale; HSCL, Hopkins Symptom Checklist; IES, Impact of Event Scale; JCS, Jalowiec Coping Scale; MHI, Mental Health Index; NEW, measure developed by authors; MOS-HIV, Medical Outcomes Study HIV Health Survey; PSS, Perceived Stress Scale; POMS, Profile of Mood States; POMS TMD, Profile of Mood States, Total Mood Disturbance; QOL, Quality of Life; Q-LES-Q, Quality of Life Enjoyment and Satisfaction Questionnaire; SLC-90-R, Symptom Checklist 90-R; SF-36, Medical outcomes study short-form 36; SIP, Sickness Impact Profile; SSSS, Sources of Social Support; SWB, Spiritual Well-Being Scale; SRS, Social Relationships Scale; SPS, Social Provisions Scale; SSQ, Social Support Questionnaire; STAI, State-Trait Anxiety Inventory; WOC, Ways of Coping Questionnaire.

^aWhen reported, subscales of measures were used to assess a particular dependent variable. None of the measures were used to assess multiple constructs.

Appendix 3

Figure 3.1.
Selection process for study inclusion in the meta-analysis.

Figure 3.2. Forest plot of the effect sizes and their 95% confidence intervals for coping. The square representing each effect size is proportional to its weight in the analysis. None of the effect sizes significantly favored the treatment or control conditions.

Figure 3.3.

Forest plot of the effect sizes and their 95% confidence intervals for social support. The square representing each effect size is proportional to its weight in the analysis. None of the effect sizes significantly favored the treatment or control conditions.

Figure 3.4.

Forest plot of the effect sizes and their 95% confidence intervals for anxiety (after removal of 1 outlier: Taylor et al., 1995). The square representing each effect size is proportional to its weight in the analysis. Effect sizes significantly favoring the treatment groups appear in white (none of the effect sizes significantly favored the control condition).

Figure 3.5.

Forest plot of the effect sizes and their 95% confidence intervals for distress (after removal of 2 outliers: Caddick, 1995; Taylor et al., 1995). The square representing each effect size is proportional to its weight in the analysis. None of the effect sizes significantly favored the treatment or control conditions.

Figure 3.6.

Forest plot of the effect sizes and their 95% confidence intervals for quality of life (after removal of 2 outliers: Stringer et al., 1998 [Moderate Exercise and Heavy Exercise]). The square representing each effect size is proportional to its weight in the analysis. Effect sizes significantly favoring the treatment groups appear in white (none of the effect sizes significantly favored the control condition).

Figure 3.7.

Forest plot of the effect sizes and their 95% confidence intervals for viral load. The square representing each effect size is proportional to its weight in the analysis. None of the effect sizes significantly favored the treatment or control conditions.

Figure 3.8.

Forest plot of the effect sizes and their 95% confidence intervals for hormonal. The square representing each effect size is proportional to its weight in the analysis. None of the effect sizes significantly favored the treatment or control conditions.

Figure 3.9.

Forest plot of the effect sizes and their 95% confidence intervals for fatigue (after removal of 1 outlier: Galantino et al., 2005 [Tai Chi]). The square representing each effect size is proportional to its weight in the analysis. Effect sizes significantly favoring the treatment groups appear in white (none of the effect sizes significantly favored the control condition).

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Figure 1. Schematic of the psychoneuroimmunology model of HIV infection after exposure to stress management training (adapted from Antoni, 2003).

Figure 2.

Forest plot of the effect sizes and their 95% confidence intervals for depression (after removal of 1 outlier: LaPerriere et al., 1990 [Aerobic Exercise]). The square representing each effect size is proportional to its weight in the analysis. Effect sizes significantly favoring the treatment groups appear in white (none of the effect sizes significantly favored the control condition).

Figure 3.

Forest plot of the effect sizes and their 95% confidence intervals for CD4+ counts (after removal of 1 outlier: Stout-Shaffer, 1999). The square representing each effect size is proportional to its weight in the analysis. None of the effect sizes significantly favored the treatment or control conditions.

Table 1
Efficacy of stress management interventions for HIV-seropositive adults at first measurement occasion.

Outcome ^a	k of interventions	Weighted mean <i>d</i> (and 95% confidence interval)		Homogeneity of effect sizes		<i>P</i>	Variation due to heterogeneity <i>I</i> ² index (and 95% uncertainty interval)
		Fixed effects	Random effects	<i>Q</i>			
Coping	8	0.10 (-0.05, 0.26)	0.10 (-0.05, 0.26)	1.40	.99		0%
Social support	11	0.01 (-0.15, 0.17)	0.01 (-0.15, 0.17)	6.45	.77		0%
Anxiety	22	0.28 (0.17, 0.40)	0.31 (0.14, 0.48)	39.77	.01		47% (13%, 68%)
Depression	34	0.28 (0.19, 0.37)	0.29 (0.18, 0.41)	45.51	.07		27% (0%, 53%)
Distress	13	0.19 (0.06, 0.33)	0.19 (0.06, 0.33)	3.86	.99		0%
Quality of Life	18	0.16 (0.05, 0.27)	0.16 (0.05, 0.27)	11.83	.81		0%
CD4+ count	21	0.04 (-0.11, 0.18)	0.04 (-0.11, 0.18)	17.32	.63		0%
Viral load	8	-0.09 (-0.31, 0.13)	-0.09 (-0.31, 0.13)	3.92	.79		0%
Hormonal	5	-0.14 (-0.40, 0.11)	-0.17 (-0.62, 0.27)	11.80	.02		66% (12%, 87%)
Fatigue	8	0.38 (0.16, 0.59)	0.38 (0.16, 0.59)	2.65	.91		0%

^aExtreme outliers were excluded for the anxiety (Taylor et al., 1995), depression (LaPerriere et al., 1990 [aerobic exercise]), distress (Caddick, 1995; Taylor et al., 1995), quality of life (Stringer et al., 1998 [moderate exercise and heavy exercise]), CD4+ count (Stout-Shaffer, 1999), and fatigue (Galantino et al., 2005 [Tai Chi]) dependent variables. The direction and significance of the weighted mean effect sizes and homogeneity tests including outliers were consistent with the results excluding outliers.