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ORIGINAL ARTICLE

THE EFFECT OF YOGA ON REDUCING STRESS AND IMPROVING CD4 COUNTS AMONG PEOPLE WITH HIV: A SYSTEMATIC REVIEW AND META-ANALYSIS

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ABSTRACT

Stress is a common mental health problem among HIV patients. Yoga has been frequently used to manage stress, but its potential benefits are not well-established yet. The aim of this meta-analysis is to assess the effect of yoga intervention on reducing stress and improving CD4 among HIV populations. Electronic bibliographic databases were systematically searched for articles reporting randomized controlled trials on yoga, HIV, and stress. The inclusion criteria were studies that (a) assessed yoga intervention in HIV patients; (b) included control groups; (c) evaluated psychological stress or biomarkers of stress as the outcome; and (d) provided mean and standard deviation scores for both groups to calculate the effect size. Meanwhile, our exclusion criteria were studies that (a) used other than randomized controlled trial design; (b) were written in a language other than English; and (c) included participants other than HIV patients. Six studies were sampled, with a total of 348 participants that met our criteria. HIV positive participants who received yoga interventions reported significantly reduced psychological stress compared to control group (total effect size was -0.85, with 95% CI from -1.47 ~ -0.23). Thus, yoga is a stress management exercise that health care providers can use to treat HIV patients.

Keywords: *HIV/AIDS; meta-analysis; stress; yoga*

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INTRODUCTION

Psychological stress is one of the most common mental health problems among people living with HIV (PLWH). Considering the lengthy course of HIV medication and the stigma associated with the disease, it is unsurprising that PLWH experiences stress related to the disease. The prevalence of stress among PLWH is estimated to be as high as one-third of all people with the disease in developing countries (Ayano et al., 2020), and it has gotten worse during the COVID-19 pandemic (West et al., 2022). Most HIV patients confront multiple stressors, including stress related to HIV itself (e.g., treatment with medication) and stressors not directly to HIV (social, financial, political) (Huang et al., 2020). Many scholars agree that this burden of stress contributes to lower quality of life for HIV patients, poorer drug adherence, lower work sufficiency, and raises the risk of HIV developing into AIDS (de Los Rios et al., 2021; Effendy et al., 2019; Verhey et al., 2018). According to a meta-analysis conducted by Rueda et al. (2016), higher levels of HIV-related stigma are significantly correlated with greater rates of depression, lower levels of social support, compliance with medication treatment, and access to medical services. In clinical settings, stress among PLWH can often go unrecognized by healthcare professionals or by the patients themselves (Felker-Kantor et al., 2019). Even if recognized, assessment and treatment may not be initiated, and even if they are, the treatment for stress may not be successful (Tong et al., 2020).

With the growing interest in mindfulness-based therapy for psychological stress among PLWH, several such interventions have been scientifically successful at reducing

stress and improving the health and well-being of HIV-positive people. For example, mindfulness-based therapies have been proven effective in coping with stress and improving mental health outcomes among PLWH (Scott-Sheldon et al., 2019). Cognitive-behavioral therapy has also been proven to be effective in reducing symptoms of depression and enhancing adherence to antiretroviral medications (Safre et al., 2021).

Moreover, a meta-analysis of stress management interventions among women living with HIV indicates the benefits of stress management interventions for a variety of psychological conditions, such as stress, depression, and anxiety, in addition to fatigue, adhering to treatments, and quality of life (Waldron et al., 2021). The interventions assessed in that meta-analysis included yoga, tai chi, meditation, and aerobic exercise.

Yoga, a type of mind-body exercise that incorporates physical movement, breathing methods, and meditation (Brinsley et al., 2021), is becoming a part of integrative healthcare, and a growing body of evidence supports its use as a complementary therapy. Popular types of yoga practices include Iyengar yoga, Hatha yoga, and Sudarshan Kriya Yoga. Hatha yoga generally focuses more on postures (*asanas*) and body motions, while most Western yoga practices involve breathing and meditation (Decker et al., 2019). Iyengar yoga, a Hatha variety, consists mostly of poses with exact alignment along with breathing techniques (Lutz et al., 2019) and sometimes includes the use of additional equipment, such as chairs and cushions, to make yoga more accessible to people with different degrees of yoga experience and physical limitations. Additionally, practicing Iyengar yoga has been shown effective for dealing with chronic pain (Kempert, 2020), improving physical health, and emotional functioning among pediatric obesity patients for disturbing emotions, such as despair, anxiety, rage, and anger (Hainsworth et al. 2018). Sudarshan Kriya yoga uses various breathing methods and has been shown to improve sleep quality while reducing feelings of depression, stress, and anxiety (Sloan & Kanchibhotla, 2021; Vasudev et al., 2020).

As yoga is becoming more popular in clinical settings, it is increasingly used for reducing stress among PLWH. Mind-body methods such as yoga are particularly popular among PLWH (Agarwal et al., 2015). However, their potential benefits in this group are not yet well-established. According to a randomized controlled trial comparing yoga intervention and treatment as usual (Wimberly et al., 2018), yoga was found to have improved mental outcomes, reduced stress, and reduced the use of mind-altering substances among people with HIV who were reentering society from jail or prison. Previous reviews and meta-analyses of the effects of yoga mostly focus on a broad range of psychological conditions as outcomes. Our objective is to evaluate whether yoga therapy can improve outcomes specifically related to psychological stress and CD4 counts in PLWH and to present our findings as a basis for future scientific research.

METHOD

Study design

This study followed the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) developed by Moher, Liberati, Etzlaff, Altman, and PRISMA Group (2009). The PRISMA checklist is included as a supplemental document (Figure 1).

Eligibility criteria

This review included randomized controlled trial studies that (a) assessed yoga intervention for PLWH; (b) included control groups; (c) evaluated psychological stress or biomarkers of stress as the outcome; and (d) provided mean and standard deviation scores for both groups to calculate the effect size; (e) provided information regarding the disease progression (e.g., CD4 counts) and biomarker of stress (e.g., cortisol). Meanwhile, our exclusion criteria were studies that (a) used other than randomized controlled trial design; (b) were written in a language other than English; (c) included participants other than HIV patients.

Information source and search strategies

A comprehensive search strategy was used to find studies in electronic bibliographic databases, such as PubMed, CINAHL, Medline, ProQuest, and the Cochrane Library. Data collection occurred from February to March 2022. The search for relevant literature was done using broad search terms, such as “HIV,” “yoga,” and “stress.” To zoom in on the topic specifically, the search strategy used a Boolean search plan with the following keywords: “HIV’ OR “human immunodeficiency virus” OR “AIDS” OR “HIV/AIDS” OR “PLWH” OR “PLWA” OR “PLHA” OR “people living with HIV” OR “people living with HIV/AIDS” OR “HIV+” OR “HIV-positive” OR “HIV Seropositivity” OR “HIV individual” AND "Yoga" OR "Mind-Body Relaxations” OR “Yogic” OR “Hatha” OR “asana” OR “Pranayama” OR “Dhyana” OR “Vinyasa” OR “Body mind exercise” AND "Stress, Psychological OR “Stress” OR “Psychological stress.” We modified the electronic bibliography database search strategy for each database website when necessary. For example, by adding or removing the MeSH (Medical subject headings) text word search in titles and abstracts [tw] and eliminating wildcards [*].

Study selection

In the first step, we removed all duplicate articles. Next, two examiners reviewed the titles and abstracts to determine studies that were eligible for inclusion in our review. Review studies and meta-analyses were removed, along with studies that were not RCTs. Moreover, studies that did not involve PLWH were not included in this study. Studies where the outcomes did not include stress and those where the intervention was not yoga were also excluded from consideration. The two authors obtained the complete text of the remaining papers and examined them for eligibility. The remaining papers were retained for the next step; the literature review and meta-analysis.

Summary measure

We calculated the effect sizes between the groups (yoga group and control group) for differences in psychological stress and biomarkers of disease progression. If the studies had more than one post-test, we only included the last post-test result. Effect sizes were calculated by dividing the mean differences between the yoga intervention and control groups or comparing post-test outcomes with pre-test standard deviations (Becker, 1988; Morris & DeShon, 2002). All effect sizes were corrected for sample size bias (Hedges, 1981). Positive effect sizes indicate that participants in the yoga intervention group had improved outcomes compared to the control group. The two authors calculated the effect sizes independently and reconciled the differences through discussion.

Statistical analysis

The Review Manager 5.4 computer software was used for the data analysis (Copenhagen: The Nordic Cochrane Centre,

The Cochrane Collaboration, 2014). For the meta-analysis, the magnitude of Cohen's d was defined as follows a) "big" for scores bigger than 0.8; b) "moderate" for scores between 0.5 and 0.8; and c) "small" for scores between 0 and 0.5. For heterogeneity, we used the following statistical functions: a) Tau^2 for calculating the variance between studies; b) Chi^2; and c) I^2 for calculating the percentage of variation caused by heterogeneity. The most prevalent classification of I^2 considers scores above 50% to be highly heterogeneous, scores between 25% and 50% as moderately heterogeneous, and scores below 25% as having limited heterogeneity (Higgins & Thompson, 2002).

RESULTS

Study selection

In this study, a total of 98 articles were identified, consisting of 18 papers from PubMed, 17 from CINAHL + Medline, 49 from ProQuest, and 14 studies from the Cochrane Library (Figure 1). The screening process removed 21 duplicate studies, yielding a total of 77 articles. Of those 77 studies, we excluded 67, specifically: 27 review studies, 9 studies that did not use an RCT design, 14 studies whose participants were not PLWH, 7 studies in which stress was not an outcome, 3 studies in which the intervention was not yoga, and 7 studies where the CD4 results were not presented. Ten studies met our inclusion and exclusion criteria and were eligible for our review. Two more studies were removed because their study design did not include a control group. Another two were also removed because they did not provide statistical results to calculate the effect size. After careful analysis, six studies were eligible for the meta-analysis.

Study characteristics

The summary of the papers' characteristics is presented in **Table 1**. Of the total 348 participants in the six studies, 176 were assigned to a yoga intervention group and 172 to a control group. The studies included in our paper were published between 2006 and 2018, with four studies conducted in North America and two studies conducted in South-Asia (India). The participants were recruited from several different settings, including outpatient clinics, medical centers, HIV/AIDS clinical trial networks, and HIV-specific service organizations. All studies randomly assigned participants to a yoga group and compared them with a control group receiving routine care.

Participants' characteristics

The average age of participants across the six studies was 43 years (SD = 7.9). Moreover, of the total 348 participants, 50 were male, 103 were female, and 2 were transgender. However, our research found that two studies did not include information on the age and gender of participants (Brazier et al., 2006; Hrushikes & Sharma, 2017). In one study, the participants had been diagnosed with HIV and/or AIDS an average of 11 years ago, but other studies did not include the duration of the disease (Cade et al., 2010). Antiretroviral treatment (ART) was administered to roughly 50.7% of patients in the trial reported by Wimberly et al. (2018). All six studies clearly documented participants' stress status before and after the intervention. Two studies measured stress using the Perceived Stress Scale, and one used the Daily Stress Inventory. Meanwhile, three studies used CD4 counts as a biological stress marker and one measured cortisol levels.

Assessing the risk of bias

Table 2 shows the risk of bias for the six studies included in the meta-analysis following the recommendations of the Joanna Briggs Institute of Systematic Review for Randomized Controlled Trials. This tool is designed to analyze the quality of randomized controlled studies. The highest possible score using the JBI checklist is 13, with each item having four possible answers: Yes, No, Unclear, or Not applicable. One point is given if the answer is Yes and zero if the answer is No, Unclear, or Not applicable. The first and second authors of the current study independently assessed the quality of evidence, deciding whether or not an article met the inclusion criteria. When there was no consensus on the inclusion or exclusion of the study, the dilemma was solved by consulting the two other researchers who participated in this study.

In our study, according to JBI, the studies conducted by Agarwal, Kumar, & Lewis (2015) and Cade et al. (2010) scored 10 by the first author and 9 from the second author. Moreover, the study by Brazier, Mulkins, and Verhoef (2006) scored 10 by both authors. Next, the study by Naoroibam, Metri, Bharghav, Nagaratna, & Negendra (2016) scored 9 by both authors. In addition, the study conducted by Wimberly, Engstrom, Layde, & McKay (2018) scored 9 by the first author and 10 by the second author. The last study conducted by Sharma & Hrushikesh (2017) scored 8 by the first author and scored 5 by the second author, thereby indicating that this study's quality was not very good.

Intervention characteristics

The details of the yoga interventions in all six studies are shown in Table 1. The types of yoga used included Hatha, Asanas, Ashtanga Vinyasa, and integrative practices. Our review found that the components of yoga most widely practiced among PLWH were breathing exercises (Pranayama), body postures (Asanas), and meditation (Dhyana). The total average duration of yoga interventions offered to the participants was 10.6 weeks, and the total number of sessions ranged from 16 to 90.

Assessment of results

Stress as an outcome

In our study, three articles examined stress by using a self-report scale. Two studies used the Perceived Stress Scale, and one study measured stress using the Daily Stress Inventory. The Perceived Stress Scale is available in three different versions, each with a different number of items. One version contains 14 items (the PSS-14), another contains 10 items (PSS-10), and the third has 4 items (PSS-4). To assess the frequency of stressful situations, these scales use five-point Likert-type responses (from never to very often). In addition, the Daily Stress Inventory is a self-report measure of minor stressors administered to patients daily. This scale has been revised multiple times, resulting in many different versions with a varying number of items.

Table 1. Characteristics of studies, participants, and interventions

Author	Study site	Characteristic of participants			Intervention detail					Tools	Outcomes
		n	Age (Mean, SD)	Gender	Type of yoga	Component of yoga	Control	Duration (weeks)	Session (total)		
Agarwal, Kumar, & Lewis (2015)	Medical Wellness Centre, Miami, the United States	Total: 24 IG: 12 CG: 12	IG: 47.0±8.9 CG: 49.3± 4.1	Male/Female IG: 8/4 CG:7/5	Integrative	Physical posture, Breathing practice, Relaxation, Meditation	Routine care	8	16	Perceived stress scale (PSS) and cortisol	- PSS: IG: 18.6±8.5 CG: 24.2±3.8 - Cortisol: IG: 3.780±2.678 CG:1.822±1.273
Brazier, A., Mulkins, A., & Verhoef, M (2006)	Community HIV/AIDS organization, Vancouver Canada	Total: 47 IG:20 CG: 27	IG: - CG: -	Male/Female IG: - CG: -	Integrative	Physical posture, Breathing practice, Relaxation, Meditation	Routine care	8	16	Daily Stress Inventory (DSI)	IG: 58.6±3.46 CG: 63.5±3.46
Cade et al., (2010)	AIDS Clinical Trials Unit of the Washington University, MO, USA	Total: 60 IG: 34 CG: 26	IG: 45±6 CG: 45±10	Male/female IG: 0/24 CG: 0/29	Asthanga Vinyasa	Physical posture, Breathing practice, Relaxation, Meditation	Routine care	20	50	CD4+	IG: 507±134 CG: 592±268
Naoroibam, Metri, Bharghav, Nagaratna, & Negendra, (2016)	HIV rehabilitation Center, Manipur State, India	Total: 44 IG: 22 CG: 22	IG: 36.92±5.41 CG: 35.36±8.27	Male/Female IG: 10/12 CG:14/8	Asanas	Physical posture, Breathing practice, Relaxation, Meditation	Routine care	4	24	CD4+	IG: 388.3±78.11 CG: 304±87.72
Hrushikes., & Sharma, (2017)	HIV Network Center Mangalore City, India	Total: 100 IG: 50 CG: 50	IG: - CG: -	Male/female IG: - CG: -	Integrative	Physical posture, Breathing practice, Relaxation, Meditation	Routine care	12	90	CD4+	IG: 634.31±204.65 CG: 519.65±218.33
Wimberly, Engstrom, Layde, & McKay (2018)	HIV/AIDS service organization, Philadelphia, United States	Total: 73 IG: 38 CG: 37	IG:43.30±10.59 CG:45.61±10.33	Male/Female /Transgender IG: 29/7/1 CG: 21/14/1	Hatha	Physical posture, Breathing practice, Relaxation, Meditation	Routine care	12	90	Perceived stress scale (PSS)	IG:18.43±8.78 CG: 21.81±6.87

N: Total participants
IG: Intervention group
CG: Control group
Note: The score in the outcomes was the last measures from each group including intervention group and control group.

Table 2. Risk of bias according to the JBI Critical Appraisal Tool

Study	JBI items													Total
	1.Was true randomization used for assigning participants to treatment groups?	2. Was allocation to treatment groups concealed?	3. Were treatment groups similar at the baseline?	4. Were participants blind to treatment assignment?	5. Were those delivering treatment blind to treatment assignment?	6. Were outcomes assessors blind to treatment assignment?	7. Were treatment groups treated identically other than the intervention of interest?	8. Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?	9. Were participants analyzed in the groups to which they were randomized?	10. Were outcomes measured in the same way for treatment groups?	11. Were outcomes measured in a reliable way?	12. Was appropriate statistical analysis used?	13. Was the trial design appropriate, and any deviations from the standard RCT design accounted for in the conduct and analysis of the trial?	
Agarwal, Kumar, & Lewis (2015)	Y / Y	Y / Y	Y / U	N / N	N / N	N / N	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y	10 / 9
Brazier, Mulkins, & Verhoef (2006).	Y / Y	Y / Y	Y / Y	N / N	N / N	N / N	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y	10 / 10
Cade et.al. (2010)	Y / Y	Y / U	Y / Y	N/ N	N / N	N / N	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y	10 / 9
Naoroibam, Metri, Bharghav, Nagaratna, & Negendra (2016)	Y / Y	N / U	Y / Y	N / N	N / N	N / N	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y	9 / 9
Sharma & Hrushikesh (2017)	U / U	N / N	Y / U	N / N	N / N	N / N	Y / Y	Y / U	Y / Y	Y / Y	Y / Y	Y / N	Y / Y	8 / 5
Wimberly, Engstrom, Layde, & McKay (2018)	Y / Y	N / Y	Y / Y	N / N	N / N	N / N	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y	Y / Y	9 / 10

Note: Y: Yes; N: No; U: Unclear

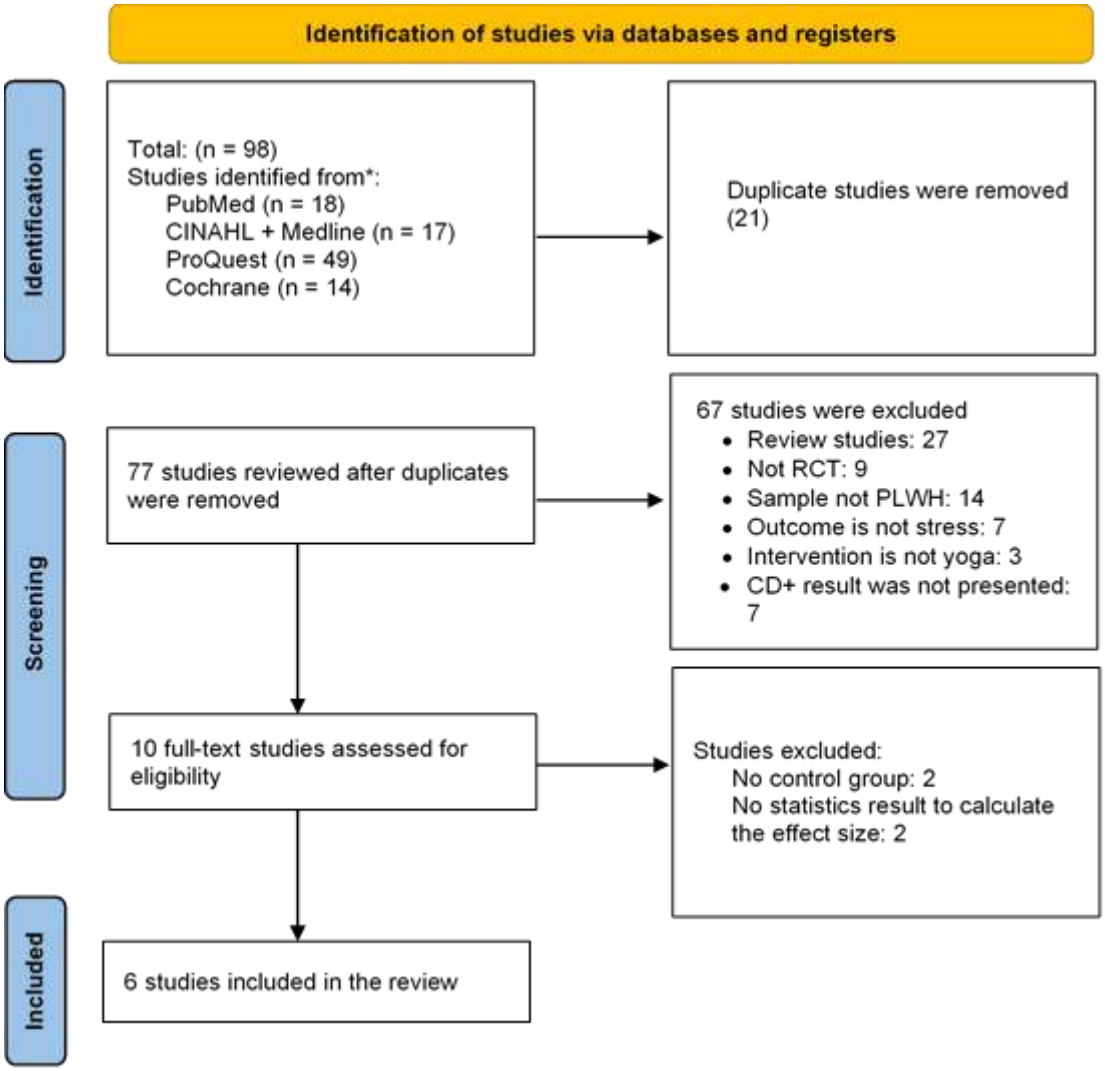
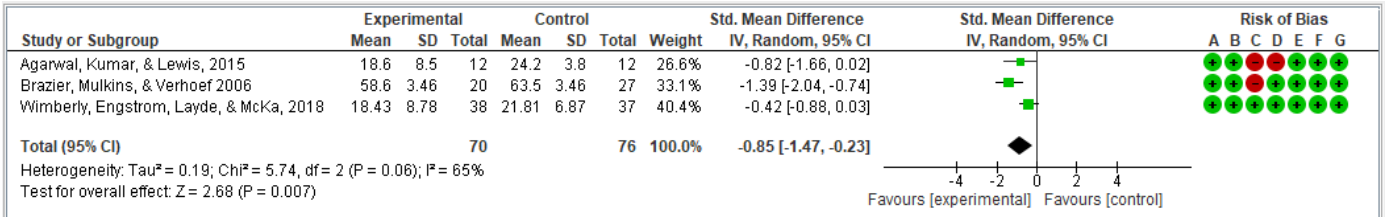
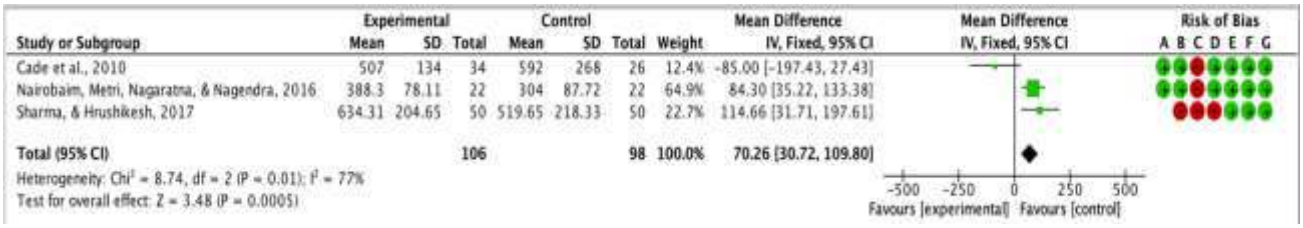


Figure 1. Screening and selection procedures based on the PRISMA statement



Risk of bias:
A: Random sequence generation (selection bias)
B: Allocation concealment (selection bias)
C: Blinding of participants and personnel (performance bias)
D: Blinding of outcome assessment (detection bias)
E: Incomplete outcome data (attrition bias)
F: Selective reporting (reporting bias)
G: Other bias
Red color: positive bias
Green color indicates negative bias

Figure 2. Meta-analysis results regarding the effect of yoga intervention toward stress among people living with HIV



Risk of bias:
A: Random sequence generation (selection bias)
B: Allocation concealment (selection bias)
C: Blinding of participants and personnel (performance bias)
D: Blinding of outcome assessment (detection bias)
E: Incomplete outcome data (attrition bias)
F: Selective reporting (reporting bias)
G: Other bias
Red color: positive bias
Green color indicates negative bias

Figure 3. Meta-analysis results regarding the effect of yoga intervention toward CD4 level among people living with HIV

Our findings show that all three studies that used the subjective scale found that participants who received a yoga intervention had a significantly greater reduction of stress compared to the control group. The total effect size (Figure two) was -0.85. The 95% CI from -1.47 ~ -0.23. The level of heterogeneity was high. Tau^2 = 0.19, Chi^2 = 5.74, df = 2 (p = 0.06), I^2 = 71%; and the test for total effect: Z = 2.68 (p = 0.007). The result showed the SMD (Standard Mean Difference) was -0.85 (95%CI -1.47~ 0.23; p = 0.06), indicating that the experimental group performed better than the control group in the stress score (**Figure 2**).

CD4 level

CD4 counts are one of the biological indicators of the severity of HIV disease. It is also reflecting the stress levels, with lower CD4 indicating greater disease progression and more stress. Normally, CD4 counts are assessed by collecting blood samples. We collected the CD4 value in both the intervention and control groups after the intervention. In our review, we found three studies that assessed the effect of yoga interventions on CD4 levels among HIV patients. Figure 3 shows that two studies found positive and significant results, showing that yoga intervention improved CD4 levels among the yoga group versus the control group (Naoroibam, Metri, Bharghav, Nagaratna, & Negendra, 2016; Hrushikes., & Sharma, 2017). Conversely, one study found that yoga intervention negatively affected CD4 levels. In our meta-analysis, the total effect size was 70.26 with 95% CI, ranging from 30.72 to 109.80. The level of heterogeneity was high: (Chi^2 = 8.74, df = 2 (p <0.01), I^2 = 77%); and the test for total effect: Z = 3.48 (p = 0.0005). The results showed a mean difference of 70.26 (95%CI 30.72~109.80; p=0.0005), indicating that the experimental group did not perform better than the control group on CD4 counts in CD4 values (**Figure 3**). In other words, yoga interventions did not improve CD4 counts.

Cortisol level

The present meta-analysis also investigated the effects of yoga on physiological stress markers, such as blood pressure, heart rate, and cortisol. Only one research article measured blood pressure (cade et al., 2010), while another evaluated salivary cortisol (Agarwal et al., 2015). Effect sizes could not be computed in this meta-analysis because no physiological markers of stress were assessed by two or more studies.

DISCUSSION

This review and meta-analysis assessed the evidence for using yoga as an intervention to reduce stress in PLWH. Previous meta-analyses have studied yoga as a complementary treatment approach with potential advantages for a variety of health disorders, including psychological disorders (Dunne et al., 2019), chronic pain (Li et al., 2019), easing arthritis symptoms (Ye et al., 2020), and reducing blood pressure (Khandekar et al., 2021). However, limited research has explored yoga as an adjuvant therapy for HIV, specifically for stress management. In our searches related to yoga and stress, only six empirical studies offered evidence of the efficacy of yoga intervention for reducing stress among PLWH.

The findings of this meta-analysis established preliminary evidence that yoga is useful as a stress and psychological management tool for PLWH based on self-reported assessments. The results from three rigorous RCTs showed that yoga significantly reduces psychological distress among PLWH. These results are consistent with an earlier systematic review of yoga for PLWH, which similarly found that yoga was useful in reducing psychological problems (Dunne et al., 2019). Previous studies focused on the effect of yoga on psychological problems from a broad perspective. Meanwhile, our current study specifically explored the effect of yoga on stress reduction among PLWH. Previous authors cited seven studies focusing on depression, stress, and anxiety. On the other hand, this study cited 6 studies that specifically measured stress, three of which measured stress using self-report questionnaires (one of them also measured the biomarker of stress), and another three studies measured disease progression (CD4). Different research questions will lead to different approaches and conclusions.

Furthermore, a systematic review of yoga for reducing the physical and psychological symptoms of HIV found a significant decrease in symptoms and improved quality of life (Ramirez-Garcia et al., 2019). In addition, although it concerned a different population, a systematic review of yoga for tertiary education students conducted by Breedvelt et al.

(2019) found that it significantly improved stress, depression, and anxiety. Moreover, a well-designed RCT study included in this meta-analysis found that a 12-week yoga intervention decreased psychological distress among PLWH returning to society from jail (Wimberly et al., 2018). Nevertheless, more research is required to confirm these findings and test other types of yoga, varied durations of yoga practices, and effects on HIV patients at different stages of the disease.

In our meta-analysis, yoga interventions did not provide a significant result in biological markers of disease progression among PLWH, such as CD4 counts and cortisol levels. One possible reason is the fact that the duration of intervention was short, and few studies looked at the effects of yoga on physiological stress markers. Thus, this meta-analysis was unable to compare them. In the future, additional studies using biological and physiological markers with longer-term follow-ups (e.g., one year) are required to prove its benefits objectively.

This meta-analysis has several limitations that should be considered. The first limitation is the low number of studies examining the effect of yoga programs among PLWH. Moreover, the lack of consistency in the outcomes reported across the articles used makes the comparison inconclusive. Furthermore, it is difficult to compare the results of studies where the yoga interventions had different durations and frequencies. Another limitation was the scarcity of studies that used objective measures of stress, as most studies measured outcomes using subjective self-assessment questionnaires. The absence of studies reporting objective outcomes limited our capacity to find consistent alterations in stress mechanisms and biological factors.

Furthermore, the studies included were mostly pilot trials with limited sample sizes, making them less powerful for detecting significant differences between the intervention and control groups. The fact that several studies had a single post-intervention assessment further limited this meta-analysis by not making long-term changes visible. As a result, we were unable to assess the long-term effects of yoga. Finally, the treatment of control groups differed across studies in that some assessed control groups without any intervention or placebo, while in other cases, the control group received the usual treatment. Nonetheless, these trials give promising preliminary evidence that yoga programs benefit PLWH.

CONCLUSION AND RECOMMENDATION

Based on our present review and meta-analysis, we can confidently recommend that yoga can positively affect stress among PLWH. However, there is a need for further research that utilizes rigorous techniques, such as randomized controlled trial design, to provide more reliable evidence for the clinical application of yoga for stress among PLWH. In addition, blinding participants to the research hypothesis and desired outcomes would be useful to ensure that the trials' results are more accurate. Blinding investigators or data collectors to the participants' health condition is also needed to eliminate potential bias. One option to avoid these possible sources of bias is to use a digitally administered technology assessment tool to help researchers evaluate an intervention.

If resources allow, future studies should continue collecting data for stress biomarkers, such as cortisol levels, blood pressure, and CD4 counts, as this data is often perceived as more objective. To detect changes in immune function and offer evidence of prolonged coping and psychological effects, longitudinal designs with one year of follow-up are needed. In conclusion, our review and meta-analysis results demonstrate that yoga is a viable complementary treatment for HIV-positive patients and effectively reduces psychological stress among PLWH. Therefore, healthcare providers should incorporate yoga interventions for HIV patients into their routine care, especially for those who psychologically suffer from stress.

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