



Effect of Hatha Yoga on Anxiety: A Meta-Analysis

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Abstract

Objective—Some evidence suggests that Hatha yoga might be an effective practice to reduce anxiety. To examine the effect of Hatha yoga on anxiety, we conducted a meta-analysis of relevant studies extracted from PubMed, PsycINFO, the Cochrane Library, and manual searches.

Methods—The search identified 17 studies (11 waitlist controlled trials) totaling 501 participants who received Hatha yoga and who reported their levels of anxiety before and after the practice. We estimated the controlled and within-group random effects of the practice on anxiety.

Results—The pre-post within-group and controlled effect sizes were, Hedges' $g = 0.44$ and Hedges' $g = 0.61$, respectively. Treatment efficacy was positively associated with the total number of hours practiced. People with elevated levels of anxiety benefitted the most. Effect sizes were not moderated by study year, gender, presence of a medical disorder, or age. Although the quality of the studies was relatively low, the risk of study bias did not moderate the effect.

Conclusions—Hatha yoga is a promising method for treating anxiety. However, more well-controlled studies are needed to compare the efficacy of Hatha yoga with other more established treatments and to understand its mechanism.

Keywords

Anxiety; Complementary Therapies; Meta-analysis; Systematic Review; Yoga

Introduction

Anxiety and its disorders are common mental health problems that are associated with high comorbidity, suffering, and societal burden (1). Recently, mindfulness practices have shown some promise for reducing anxiety symptoms (2, 3). However, these treatments are still not widely disseminated. In contrast, yoga, which shares many similarities to psychological mindfulness-based treatments, is more readily available and its popularity is increasing. In fact, Yoga has been adopted by the advertising industry as a symbol of health and a wholesome lifestyle. Based on a 2007 National Health Interview Survey (NHIS), yoga was the sixth most commonly used complementary health practice among adults, and between the 2002 and 2007 NHIS, use of yoga among adults increased by 1 percent or approximately 3 million people (4). The most commonly practiced form of yoga in the USA is Hatha yoga

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Conflict of Interest None

(5). Meditation is a core component of this yoga practice, both historically and in practice. This notion is consistent with the definition of Hatha yoga by the National Center for Complementary and Integrative Health (6), which considers meditation an important component next to physical postures, breathing exercises, and a distinct philosophy as of yoga.

Despite its popularity, no quantitative review of Hatha yoga as a possible treatment for anxiety exists. Therefore, the goal of the present study was to provide a systematical review of the efficacy of yoga for reducing anxiety symptoms. Although there are many different forms of yoga practices, we limited our review the Hatha yoga, the most common form of yoga practice. We tested the hypothesis that Hatha yoga is an effective treatment for reducing symptoms of anxiety.

Methods

Search

A search of PubMed, PsycINFO and Cochrane Library databases was conducted on September 18, 2015. The following search terms were used: *yoga* AND (*anxiety* OR *anxious* OR *panic* OR *agoraphobia* OR *social phobia* OR *social anxiety* OR *sad* OR *generalized anxiety* OR *gad* OR *obsessive compulsive* OR *obsessive-compulsive* OR *ocd* OR *specific phobia* OR *simple phobia* OR *post-traumatic stress* OR *post-traumatic stress* OR *posttraumatic stress* OR *ptsd* OR *acute stress* OR *asd*). The initial search produced 2 234 results, with 946 studies remaining after duplicates and resources reporting data presented in another selected study were excluded. In accordance with the guidelines set forth in Preferred Reporting Items for Systematic Reviews and Meta-analysis Protocols (7) the protocol for this meta-analyses was registered in with the International Prospective Register of Systematic Reviews (PROSPERO) on September 9, 2015, and was last updated on February 2, 2016 (registration number CRD42015026303).

Study Selection

Studies were included in the present meta-analysis if: 1) at least one treatment condition consisted of a course of Hatha yoga (i.e. no single-session interventions); 2) they included an adequate measure of anxiety at pre- and post-intervention; 3) they included a sample of adults 18 years or older; and 4) they provided sufficient data on the intervention of interest for calculating an effect size to use in our meta-analysis.

Studies were excluded if: 1) the bibliographic resource was a review, a meta-analysis, a survey, a manual or a conference abstract; 2) Hatha yoga was not described as “pure” Hatha, meaning: a) the authors explicitly define that just one or some component of Hatha yoga were used (e.g. only breathing or poses); b) Hatha yoga was defined as explicitly and drastically modified from the traditional method, with the introduction of not-conventional procedures; or c) the yoga descriptions were too ambiguous to define the yoga style as Hatha; 3) Hatha yoga was administered in conjunction with another active treatment. In cases of disagreement, the authors discussed the case until consensus was reached. If a study met all other inclusion criteria, but the data necessary to calculate an effect size were not

reported, we emailed the corresponding author to request the necessary data to conduct the analyses.

Data Extraction

For each selected study, the second author and four independent trained assessors extracted data on anxiety measures at pre-treatment and post-treatment for the Hatha yoga arms, along with data from non-active control conditions if included. In addition, we extracted data on sample and study characteristics, including sample size, duration and frequency of treatment, gender distribution, age, and whether the sample consisted of a medical population, and publication year. Because there is no standardized protocol for the delivery of Hatha yoga, we also identified and extracted the components of the interventions as described by the authors of each study, which included yoga postures, breathing techniques, relaxation, meditation, and other techniques such as mindfulness or acceptance. Data were extracted on two separate occasions by independent raters and compared to ensure reliability, with discrepancies resolved by the second author.

Risk of Bias Assessment

In accordance with the Cochrane guidelines for systematic reviews (8), we assessed study quality with the Cochrane Collaboration's tool for assessing risk of bias (9). This tool involves assessing each study as containing a high, low or unclear level of bias risk in a number of domains using pre-specified criteria. The domains used in our assessment were: 1) Sequence Generation, which assesses whether allocation of participants to treatment condition are adequately generated in a random manner; 2) Allocation Concealment, which assesses whether treatment assignment was adequately concealed from investigators and participants prior to randomization; 3) Incomplete Outcome Data, which assesses whether outcome data are missing at random and imputed using appropriate methods; and 4) Selective Outcome Reporting, which determines whether pre-specified outcome variables of interest are adequately and completely reported. Although this tool was initially designed for assessment of randomized controlled trials, the Cochrane guidelines specify that it may be adapted for the evaluation of non-randomized trials (8). In doing so, we assigned non-randomized trials a high risk rating in the sequence generation category. Following recommendations from the Cochrane guidelines, a total bias assessment was created for each study such that an 'unclear' rating in any category meant an 'unclear risk' overall rating unless there was a 'high' rating in any category, which lead to a 'high risk' overall rating. 'Low risk' studies had to be rated as 'low' in all four categories. The third and fourth authors independently rated each study and then met to resolve any discrepancies. Inter-rater reliability for the total bias assessment was strong ($Kappa = .74$; $SE = .17$).

Data Analyses

The meta-analytic procedures were conducted in Comprehensive Meta-Analysis, Version 3. We used a random effects model because of the heterogeneity within the studies. Within-group and controlled effect sizes were calculated using Hedges' g (10).

To investigate potential moderator effects on outcome, we employed the between-group heterogeneity statistic (Q_B) recommended by Hedges and Olkin (10) and meta-regression

procedures for categorical and continuous moderators, respectively. Moderators of interest included both study procedure characteristics (i.e., number of sessions, session frequency, study quality, study year) and sample characteristics (i.e., age, sex, presence of a medical condition).

To examine the presence of publication bias, we used the fail-safe N method to determine the number of additional studies with a null result needed to reduce the overall effect size to non-significance (11). We also examined the funnel plot to evaluate symmetry relative to the mean effect size, with greater symmetry corresponding to decreased likelihood of publication bias. To complement funnel plot inspection, the trim and fill method (12) was utilized to determine the nature of potential publication bias and compute an imputed effect size that accounts for such bias.

Results

Study Characteristics

Figure 1 shows the number of studies excluded at each stage of study selection, and the reasons for exclusion. Of the 2 234 studies initially identified, 17 were determined to be eligible (13–29). Together these studies examined the effect of yoga on anxiety symptoms in 501 participants. Eleven of these studies contained waitlist controls allowing for the calculation of a between-groups effect size.

Study characteristics are presented in Table 1. Results from the risk of bias assessment showed that seven studies had an unclear risk of bias, nine had a high risk of bias, and one study had a low risk of bias. Across studies, the mean study sample consisted of 75.5% female participants ($SD = 31.81$), and had a mean age of the 41.08 ($SD = 12.42$). Mean treatment duration was 8.69 weeks ($SD = 4.17$), and mean session frequency was 2.25 times per week ($SD = 1.31$). All 14 of the studies that provided descriptions of the Hatha yoga included postures, and 13 of the 14 studies included breathing techniques. Five of the studies described using relaxation techniques, seven described the use of meditation, and two studies included other components (mindfulness and awareness/acceptance exercises).

Eight of the 17 studies examined the effect of yoga on anxiety in a sample with a medical condition, and one study examined a sample with a psychological condition (panic disorder). To assess the baseline anxiety severity of each study sample, we compared mean anxiety scores at pre-test to population norms and clinical cut-offs whenever possible (Table 2). Of the 13 studies that included anxiety measures where norms and clinical cut-offs were available, four used samples with mean anxiety scores above the clinical cut-off, and an additional three studies had samples with elevated anxiety levels that were significantly greater than population means. Population means and clinical cut-offs for the measures where such data were available were as follows: State Trait Anxiety Inventory – Trait (STAI; 31): population mean = 36.35 ($SD = 11.39$; 39), clinical cut-off ≥ 46 (40); Beck Anxiety Inventory (BAI; 30): population mean = 6.16 ($SD = 7.16$; 39), clinical cut-off ≥ 16 (30); Hospital Anxiety and Depression Scale - anxiety subscale (HADS-A; 32): population mean = 4.7 ($SD = 3.5$; 41), clinical cut-off ≥ 8 (42); Hamilton Anxiety Rating Scale (HAM-A; 38): ≥ 24 suggests severe anxiety (43); Depression Anxiety and Stress Scales (21 item version) –

Anxiety subscale (DASS21-A; 37): population mean = 1.74 ($SD = 2.78$; 39), clinical cut-off ≥ 6 (44).

Quantitative Data Synthesis

Within-group effect sizes

a) Pre-post within-group effects: Within-group effect sizes, confidence intervals and significance values for each study are presented in Table 3. For the within-group analysis, one outlier (Hedges' $g = 5.63$) was identified (28) and removed from subsequent analyses. The random effects meta-analysis yielded an overall effect size on anxiety of Hedges' $g = 0.44$ (95% CI : 0.25–0.63, $z = 4.491$, $P < .001$). The fail-safe N analysis for the within-group effect size was robust with $N = 432$ ($z = 10.36$). Inspection of the funnel plot reveals a distribution of effect sizes concentrated to the left of the mean effect size, which indicates a decreased likelihood of publication bias from small studies with disproportionately large effect sizes (Figure 2). Using the Trim and Fill method (12), no studies would need to fall to the left of the mean (i.e., have an effect size smaller than the mean) and 2 studies would need to fall to the right of the mean (i.e., have an effect size larger than the mean) to make the plot symmetrical, suggesting that the computed effect size is a conservative estimate. The random-effects model for the new imputed mean effect size revealed a Hedges' $g = 0.69$ (95% CI : 0.41–0.56).

b) Between-group effect sizes: Between-group effect sizes, confidence intervals and significance values for each study comparing yoga to a waitlist control are presented in Table 3. The between-groups random-effects meta-analysis yielded an overall effect size of Hedges' $g = 0.61$ (95% CI : 0.25–0.98, $z = 3.32$, $P = .001$). The fail-safe N for this analysis was robust with $N = 153$ ($z = 7.56$). The Trim and Fill analysis revealed that no adjustments to the mean effect size was warranted as no studies would need to fall to the left or right of the mean to make the plot symmetrical, suggesting an unbiased effect size estimate.

Moderator Analyses—The results of the meta-regression analysis revealed that treatment efficacy was moderated by the total number of treatment hours ($B = 0.005$, $SE = 0.002$, $P < 0.05$) and number of sessions per week ($B = 0.18$, $SE = 0.05$, $P < 0.001$). Clinical severity status also moderated treatment efficacy ($Q_B = 4.65$, $df = 2$, $P < 0.05$); studies containing subjects with clinically elevated anxiety symptoms demonstrated greater efficacy (Hedge's $g = 0.72$; 95% CI : 0.34–1.09, $z = 3.75$, $P = .001$) than did those containing subjects without clinically elevated anxiety symptoms (Hedge's $g = 0.28$; 95% CI : 0.13–0.42, $z = 3.80$, $P = .001$). Effect sizes were not moderated by study year ($B = 0.07$, $SE = 0.01$, $P = n.s.$), percentage of males ($B = -0.004$, $SE = 0.003$, $P = n.s.$), presence of a medical disorder ($B = -0.24$, $SE = 0.19$, $P = n.s.$), mean age ($B = -0.003$, $SE = 0.006$, $P = n.s.$), or risk of study bias ($Q_B = 4.06$, $df = 2$, $P = n.s.$).

Discussion

To examine the effect of Hatha yoga on anxiety, we reviewed a total of 2 234 studies. We identified 17 studies (501 participants) that met the study inclusion criteria. The within-group analysis revealed an overall effect size on anxiety of Hedges' $g = 0.44$. This effect size

was robust with a low likelihood for a publication bias. In fact, the funnel plot analysis suggested that the obtained effect size was a conservative estimate. The imputed mean effect size (Hedges' $g = 0.69$) was similar to the between-groups analysis of the studies comparing yoga to a waitlist control yielded a similar sized effect (Hedges' $g = 0.61$). These results are consistent with the results of earlier qualitative reviews that reported promising effects of yoga on anxiety (45–47).

The moderator analyses suggested that more yoga practices were associated with greater benefits and the higher the level of anxiety at the beginning, the more beneficial the practices were. In fact, people with clinically elevated anxiety symptoms benefitted the most. Effect sizes were not moderated by study year, gender, presence of a medical disorder, and age. Although the quality ratings of the studies were relatively low, the risk of study bias was unlikely to moderate the effect. These findings provide preliminary support for Hatha yoga as a strategy to reduce symptoms of anxiety. However, the effect was relatively small, questioning the use of Hatha yoga as a stand-alone treatment strategy for anxiety. Therefore, combining Hatha yoga with other strategies specifically focusing on the maintenance of the anxiety problems (such as the cognitive and behavioral techniques) seems warranted.

A number of limitations should be noted. First, the results are limited by the relatively few well-controlled trials examining the effect of yoga. Better controlled studies are needed to clearly demonstrate the benefits of yoga for anxiety symptoms. The relatively limited number of studies did not allow for meaningful subanalyses to examine the differential effects of yoga on specific anxiety disorder diagnoses or even specific symptoms. Furthermore, the relatively greater benefit among people with elevated or clinical symptoms of anxiety could be the result of the regression to the mean. Waitlist controlled trials provide weak evidence for the efficacy of the active treatment. The gold-standard treatment for anxiety disorders is cognitive behavior therapy (CBT). Although effective, there is clearly room for further improvement (48). Therefore, one possible design for a future trial might be the comparison between CBT, Hatha yoga, a combination, and active placebo condition. Finally, it is unclear what the mechanism is through which yoga improves anxiety symptoms. While Hatha yoga treatment in nearly all of the included studies contained postures and breathing, some studies involved additional treatment components (e.g. meditation, mindfulness), and thus further research is needed to best understand the active ingredients in Hatha yoga for anxiety. Despite these limitations, the results of this meta-analysis provide preliminary support for Hatha yoga as a treatment for anxiety.

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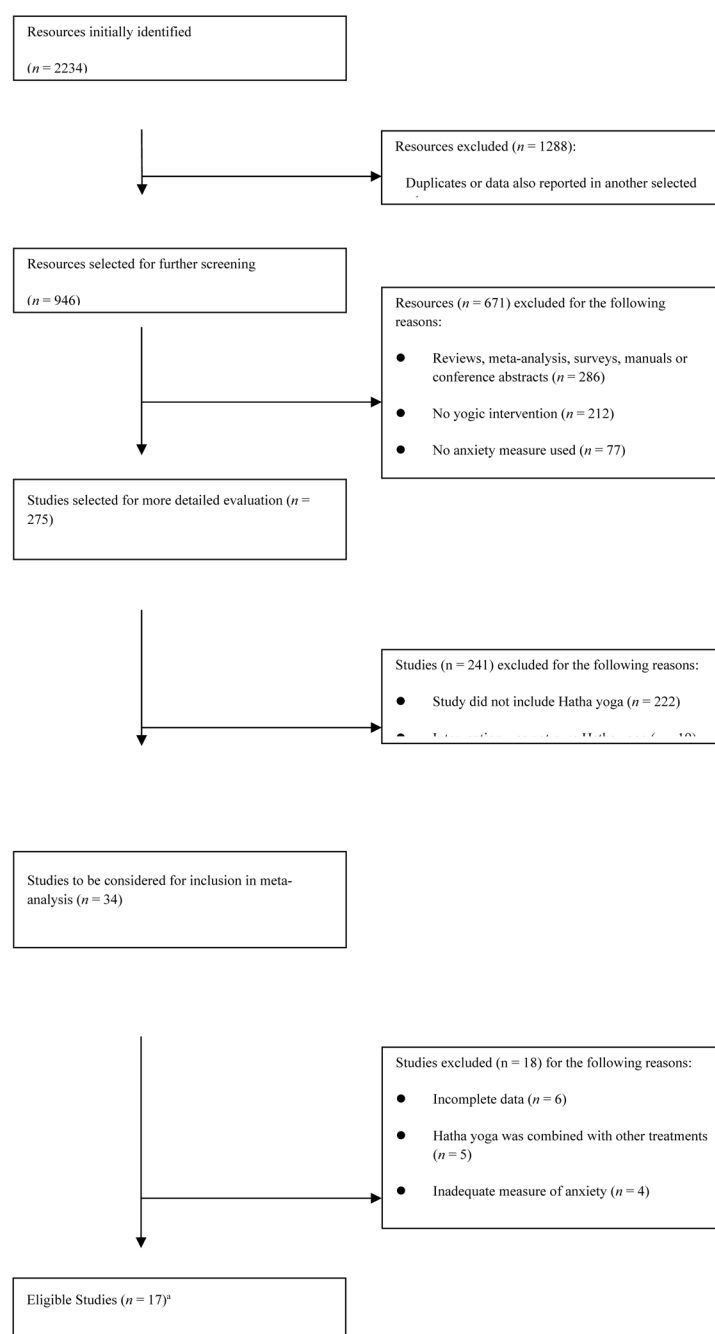


Figure 1. Flow diagram of study selection process

^aOf the 17 studies, 11 included a comparison between a non-active control group and a Hatha yoga group.

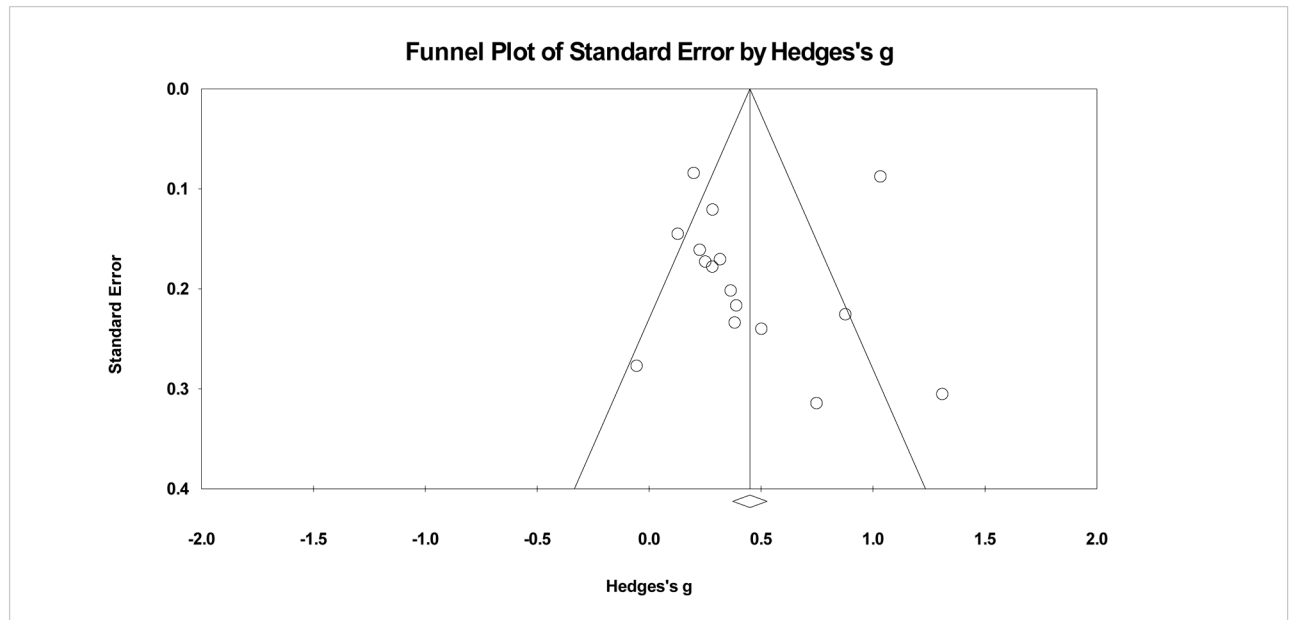


Figure 2. Funnel plot of precision by Hedges' g for quality of life measures in the pooled meta-analysis*

*This funnel plot reflects a random effects model. Horizontal and vertical axes plot the effect size and standard error of the effect size, respectively.

Table 1

Study Characteristics

Study	Hatha Yoga Components					RCT	Length of Treatment (weeks)	Sessions per week	Sample Size	Female (%)	Mean Age (SD)	Sample	Risk of Bias			
	Post	Brea	Relax	Medit	Oth								SG	AC	ID	Total
Ahmadi 2013 (13)	✓	✓	✓			Yes	8	3	11	100	32.3 (8.7)	Multiple Sclerosis patients	?	?	?	?
Baker 1979 (14)	✓	✓				Yes	4	2	20	75	NA	General population	?	?	?	?
Bernardi 2013 (15)			NA			Yes	2	3	26	100	49 (NA)	Mastectomy patients	✓	?	?	?
Bunk 1978 (16)	✓	✓				Yes	5	3	14	0	27.7 (NA)	Prison inmates	X	?	?	X
Cheema 2013 (17)	✓	✓	✓			Yes	10	3	18	78	37 (12)	University employees	✓	✓	?	?
Cramer 2015 (18)	✓	✓		✓		Yes	10	1	27	37	68.7 (9.1)	Colorectal cancer survivors	✓	✓	✓	✓
Curtis 2011 (19)	✓	✓		✓	✓ ^a	No	8	2	22	100	47.4 (13.7)	Fibromyalgia patients	X	?	?	X
Dunn 2009 (20)	✓	✓		✓		No	6	1	6	100	48.7 (14.4)	Health care employees	X	?	?	X
Holmer 2004 (21)	✓	✓	✓		✓ ^b	No	8	2	29	90	44.7 (13.2)	Fibromyalgia patients	X	?	X	X
Moadel 2007 (22)	✓	✓		✓		Yes	12	1	84	100	55.1 (10.7)	Breast cancer patients	✓	?	X	X
Pavan 1992 (23)			NA			No	NA	NA	18	100	31 (NA)	General population	?	?	?	X
Ray 2001 (24)	✓	✓	✓			Yes	20	3	28	18	23.4 (0.6)	Engineering trainees	?	?	?	?
Ruggiero 2006 (25)	✓					No	8	1	19	NA	41.4 (18.5)	University students	X	?	X	X
Sujatha 2014 (26)	✓	✓		✓		Yes	12	5	118	53	30–60 (NA)	Hypertension patients	?	?	?	?
Vizcaino 2013 (27)	✓	✓		✓		No	6	3	10	80	61.4 (6.7)	Type 2 diabetes mellitus patients	X	?	?	X
Yorkapic 2014 (28)	✓	✓	✓	✓		Yes	8	2	10	90	42.3 (7.5)	Panic disorder patients	?	✓	?	?
Yoo 2007 (29)			NA			No	12	1	41	87	47 (13.6)	University students	X	X	?	X

Definitions of abbreviations are listed below:

Hatha Yoga Components: Post = Postures; Brea = Breathing techniques; Relax = Relaxation techniques; Medit = Meditation; Oth = Other techniques;

^amindfulness exercise,

^bawareness and acceptance exercise);

NA = No description of treatment components available

Risk of Bias: SG = Sequence Generation; AC = Allocation Concealment; ID = Incomplete Outcome Data; SR = Selective Outcome Reporting; X = High Risk of Bias; ? = Unclear Risk of Bias; ✓ = Low Risk of Bias.

Table 2**Mean Baseline Anxiety Severity for Included Studies**

Study	Anxiety Measure	Sample Mean at Baseline (SD)	Baseline Anxiety Severity
Baker 1979 (14)	STAI	38.95 (11.54)	Normal
Bernardi 2013 (15)		44.31 (10.15) **	Elevated
Bunk 1978 (16)		36.64 (7.5)	Normal
Cheema2013 (17)		36.1 (10.4)	Normal
Ruggiero 2006 (25)		39.93 (8.84)	Normal
Sujatha2014 (26)		46.31 (9.05) **	Clinical
Vizcaino 2013 (27)		36.8 (11.22)	Normal
Ahmadi 2013 (13)	BAI	12.45 (4.54) *	Elevated
Dunn 2009 (14)		18.96 (11.83) **	Clinical
Cramer 2015 (18)	HADS-A	5.00 (2.08)	Normal
Curtis 2011 (19)		10.83 (4.4) **	Clinical
Vorkapic 2014 (28)	HAM-A	31.45 (1.7)	Clinical
Yoo 2007 (29)	DASS-A	4.61 (5.25) **	Elevated
Holmer 2005 (21)	AIMS2-A	16.83 (3.16)	NA ⁺
Moadel 2007 (22)	DMI-AS	9.70 (8.11)	NA ⁺
Pavan 1982 (23)	16PF-A	7.7 (NA)	NA ⁺
Ray 2001 (24)	IPAT-A	28.77 (8.80)	NA ⁺

* Significantly different from population mean (unpaired t-test) at $p < .01$;

** $p < .001$;

⁺ population means and clinical cut-offs not available

Anxiety Measures: BAI = Beck Anxiety Inventory (30); STAI = State-Trait Anxiety Inventory (31); HADS-A = Hospital Anxiety and Depression Scale-anxiety subscale (32); AIMS2-A = Arthritis Impact Measurement Scales Revised – Anxiety subscale (33); DMI-AS = Distressed Mood Index - Anxious/Sadness factor (34); 16-PF = 16 Personality Factor Questionnaire -Anxiety subscale (35); IPAT-A = IPAT Anxiety Scale Questionnaire (36); DASS21-A = Depression Anxiety and Stress Scales (21 item version) - Anxiety subscale (37); HAM-A = Hamilton Anxiety Rating Scale (38).

Hedges' g for within-group pre-post, and controlled pre-post anxiety effect sizes in each study

Table 3

Study	Pre-Post Effect Size			Pre-Post Control. Effect Size		
	Hedges' g (95% CI)	Z	P	Hedges' g (95% CI)	Z	P
Ahmadi 2013 (13)	1.31 (0.71, 1.91)	4.29	0.00	1.44 (0.51, 2.37)	3.03	0.00
Baker 1979 (14)	0.32 (-0.02, 0.65)	1.87	0.06	0.53 (-0.06, 1.12)	1.76	0.08
Bernardi 2013 (15)	0.88 (0.44, 1.32)	3.89	0.00	1.27 (0.63, 1.91)	3.91	0.00
Bunk 1978 (16)	0.37 (-0.03, 0.76)	1.81	0.07	0.41 (-0.27, 1.08)	1.18	0.24
Cheema 2013 (17)	0.28 (-0.07, 0.63)	1.60	0.11	-0.04 (-0.67, 0.59)	-0.13	0.89
Cramer 2015 (18)	0.13 (-0.16, 0.42)	.89	0.37	0.41 (-0.12, 0.94)	1.51	0.13
Curtis 2011 (19)	0.23 (-0.09, 0.54)	1.41	0.16	-	-	-
Dunn 2009 (20)	0.75 (0.13, 1.37)	2.38	0.02	-	-	-
Holmer 2004 (21)	0.39 (-0.03, 0.82)	1.80	0.07	1.13 (0.35, 1.90)	2.85	0.00
Moadel 2007 (22)	0.20 (0.04, 0.37)	2.37	0.02	0.22 (-0.15, 0.58)	1.16	0.25
Pavan 1992 (23)	0.38 (-0.07, 0.84)	1.64	0.10	-	-	-
Ray 2001 (24)	-0.05 (-0.60, 0.49)	-1.9	0.85	-0.10 (-1.23, 1.02)	-0.18	0.86
Ruggiero 2006 (25)	0.25 (-0.09, 0.59)	1.46	0.15	-	-	-
Sujatha 2014 (26)	1.04 (0.86, 1.21)	11.76	0.00	1.32 (1.04, 1.60)	9.24	0.00
Vizcaino 2013 (27)	0.50 (0.03, 0.98)	2.10	0.04	-	-	-
Yoo 2007 (29)	0.29 (0.05, 0.52)	2.35	0.02	0.16 (-0.26, 0.59)	0.75	0.46
Subtotal	0.44 (0.25, 0.63)	4.49	0.00	0.61 (0.25, 0.98)	3.32	0.00