

Efficacy of Yoga vs Cognitive Behavioral Therapy vs Stress Education for the Treatment of Generalized Anxiety Disorder

A Randomized Clinical Trial

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IMPORTANCE Generalized anxiety disorder (GAD) is common, impairing, and undertreated. Although many patients with GAD seek complementary and alternative interventions, including yoga, data supporting yoga's efficacy or how it compares to first-line treatments are lacking.

OBJECTIVES To assess whether yoga (Kundalini yoga) and cognitive behavioral therapy (CBT) for GAD are each more effective than a control condition (stress education) and whether yoga is noninferior to CBT for the treatment of GAD.

DESIGN, SETTING, AND PARTICIPANTS For this randomized, 3-arm, controlled, single-blind (masked independent raters) clinical trial, participants were recruited from 2 specialty academic centers starting December 1, 2013, with assessment ending October 25, 2019. Primary analyses, completed by February 12, 2020, included superiority testing of Kundalini yoga and CBT vs stress education and noninferiority testing of Kundalini yoga vs CBT.

INTERVENTIONS Participants were randomized to Kundalini yoga (n = 93), CBT for GAD (n = 90), or stress education (n = 43), which were each delivered to groups of 4 to 6 participants by 2 instructors during twelve 120-minute sessions with 20 minutes of daily homework.

MAIN OUTCOMES AND MEASURES The primary intention-to-treat outcome was acute GAD response (Clinical Global Impression-Improvement Scale score of much or very much improved) after 12 weeks as assessed by trained independent raters.

RESULTS Of 538 participants who provided consent and were evaluated, 226 (mean [SD] age, 33.4 [13.5] years; 158 [69.9%] female) with a primary diagnosis of GAD were included in the trial. A total of 155 participants (68.6%) completed the posttreatment assessment. Completion rates did not differ (Kundalini yoga, 60 [64.5%]; CBT, 67 [74.4%]; and stress education, 28 [65.1%]; $\chi^2 = 2.39$, $df = 2$, $P = .30$). Response rates were higher in the Kundalini yoga group (54.2%) than in the stress education group (33.0%) (odds ratio [OR], 2.46 [95% CI, 1.12-5.42]; $P = .03$; number needed to treat, 4.59 [95% CI, 2.52-46.19]) and in the CBT group (70.8%) compared with the stress education group (33.0%) (OR, 5.00 [95% CI, 2.12-11.82]; $P < .001$; number needed to treat, 2.62 [95% CI, 1.91-5.68]). However, the noninferiority test did not find Kundalini yoga to be as effective as CBT (difference, 16.6%; $P = .42$ for noninferiority).

CONCLUSIONS AND RELEVANCE In this trial, Kundalini yoga was efficacious for GAD, but the results support CBT remaining first-line treatment.

TRIAL REGISTRATION ClinicalTrials.gov Identifier: [NCT01912287](https://clinicaltrials.gov/ct2/show/study/NCT01912287)

JAMA Psychiatry. 2021;78(1):13-20. doi:10.1001/jamapsychiatry.2020.2496
Published online August 12, 2020.

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Generalized anxiety disorder (GAD) is a common condition associated with significant distress and impairment,¹ yet only approximately half of affected individuals seek care, with only one-third seen in specialty mental health settings, suggesting a substantial treatment gap.¹ Although cognitive behavioral therapy (CBT) is an effective first-line evidence-based psychotherapy for GAD,² many patients do not receive CBT because of cost, stigma,³ or logistical reasons. Similarly, pharmacotherapy may not be accessible, tolerated, or fully effective.⁴ Patients increasingly seek alternative interventions, such as yoga, often outside the medical system.^{1,5,6}

Yoga offers a popular and promising but underresearched intervention for anxiety.⁷⁻⁹ Traditional forms of yoga incorporate physical postures and exercises, breath regulation, relaxation, and meditation and mindfulness practice. The practice of yoga for health purposes has increased markedly, with 14.3% of the US population practicing in 2017.¹⁰ Although mindfulness-based approaches have efficacy for anxiety disorders, including GAD,^{11,12} the efficacy of yoga is less clear. Meta-analyses^{7,8} of yoga for anxiety have yielded inconclusive results, finding that additional rigorous investigations of yoga's efficacy for anxiety disorders (including GAD) are needed. A pilot study¹³ suggested that Kundalini yoga (KY), a safe, popular, accessible yoga style that involves all the traditional components of yoga, including breathing practices and meditation, may be considered for GAD^{14,15}; however, more research about its efficacy compared with the gold standard CBT and about its active mechanisms is needed.

The primary aim of the current randomized clinical trial (RCT) was to examine the short-term efficacy of KY compared with (1) a previously validated and standardized control condition, stress management education (stress education [SE])¹² and (2) a first-line psychotherapy, CBT for GAD.¹⁶ We hypothesized that at posttreatment assessment KY and CBT would each be superior to SE (hypotheses 1.1 and 1.2) and that KY would be noninferior to CBT (hypothesis 1.3) based on responder status, defined as a Clinical Global Impression of Improvement (CGI-I) score of much improved or very much improved. Our secondary aim was to examine the long-term efficacy of KY. We hypothesized that KY and CBT would each have higher responder rates than SE and that KY would be noninferior to CBT at 6-month follow-up (hypotheses 2.1-2.3). Our tertiary aim was to examine and compare the mechanism of treatment changes in KY and CBT. Consistent with prior literature¹⁷⁻²² and clinical beliefs about potential differences between yoga and CBT, we hypothesized that differences in response to KY vs SE would be mediated via changes in mindfulness (hypothesis 3.1), whereas differences in response to CBT vs SE would be mediated via changes in maladaptive cognitions (hypothesis 3.2).

Methods

Study Design

Generalized Anxiety: A Treatment Evaluation (GATE) was a prospective, randomized, 3-arm, parallel-group, controlled, single-

Key Points

Questions Are yoga and cognitive behavioral therapy (CBT) each more efficacious than a psychological control condition, and is yoga noninferior to CBT for the treatment of generalized anxiety disorder?

Findings In this randomized clinical trial of 226 adults with generalized anxiety disorder, 12-week group treatment with either Kundalini yoga or CBT was more effective than the stress education control condition, but the noninferiority test did not find Kundalini yoga to be as effective as CBT.

Meaning Kundalini yoga can reduce anxiety for adults with generalized anxiety disorder, but study results support CBT remaining first-line treatment.

blind (masked raters but unmasked practitioners) trial to evaluate the efficacy of 12 weeks of KY, CBT, and SE for GAD, each matched for time and practitioner contact. The trial was designed to examine the efficacy of KY and CBT compared with SE using superiority tests and to compare KY with CBT with noninferiority testing. Participants were recruited from 2 specialty academic centers starting December 1, 2013, with assessment ending October 25, 2019. Primary analyses were completed by February 12, 2020. Detailed study methods have been published elsewhere.²³ The trial protocol can be found in [Supplement 1](#). Institutional review board approvals, recruitment, and enrollment occurred at 2 academic centers (Boston University and Massachusetts General Hospital) in Boston, Massachusetts, with study coordination at an academic medical center (New York University Grossman School of Medicine) in New York. The study was overseen by the National Institutes of Health's National Center for Complementary and Integrative Health monitors and an independent data and safety monitoring board. Written informed consent was obtained for from all participants. All data except for dates were deidentified.

Participants

The planned population was 230 adults 18 years or older with a primary *DSM-5* GAD diagnosis determined by structured clinical interviews by trained clinical raters.²³ Exclusions included current posttraumatic stress disorder, substance use disorders, eating disorders, significant suicidal ideation, mental disorder due to a medical or neurocognitive condition, lifetime psychosis, bipolar disorder, developmental disorders, and having completed more than 5 yoga or CBT sessions in the past 5 years. Participants were not taking psychotropic medication for at least 2 weeks or were taking a stable dose for at least 6 weeks. Recruitment was by advertisement and clinical referral.

Randomization and Masking

Treatment was delivered in small cohorts. After 3 to 6 participants provided consent at a site, that cohort was randomized to receive a treatment using permuted block randomization (calculated before study inception) aimed at a total of 95 each for CBT and KY and 40 for SE. Treatment assignment was

revealed to participants before the first session for the first 46 participants and at the first session thereafter. Clinical ratings were performed by blinded independent evaluators, including one of us (E.B.); interrater reliability procedures occurred throughout the study.

Procedures

The 3 interventions were matched for time and practitioner contact, with 2 instructors and 3 to 6 participants per group, delivered during twelve 120-minute sessions with 20 minutes of daily homework. A credible rationale for the efficacy of all treatments was provided. All instructors were trained for certification and supervised throughout the study by expert investigators (S.B.K. for KY, S.G.H. for CBT, and E.H. for SE) to maintain fidelity and reduce cross-site variability. Sessions were recorded with a random 20% reviewed.

A standardized KY protocol was developed by the Guru Ram Das Center for Medicine and Humanology (S.B.S.K.). The protocol included physical postures and exercises, breathing techniques, relaxation exercises, meditation and mindfulness practices, yoga theory, philosophy, and psychology.²³ Cognitive behavioral therapy used an evidence-based GAD protocol, including 5 core treatment modules (psychoeducation, cognitive restructuring, progressive muscle relaxation, worry exposures, and in vivo exposure exercises) and targeted metacognitions (ie, worrying about worrying) but no explicit mindfulness components.²³ Stress education is a standardized control condition,¹² including lectures on physiologic, psychological, and medical effects of stress; effects of lifestyle behaviors, such as caffeine, alcohol, and smoking; resilience factors; and the importance of exercise and diet. Homework consisted of listening to audio files about stress, nutrition, and lifestyle.

Outcomes

The primary outcome was treatment response, defined as a CGI-I rating of much improved or very much improved²⁴ by the independent evaluator at the posttreatment assessment. The secondary outcome was response at 6-month follow-up. The CGI-I was assessed biweekly from week 0 to 12 and at 6-month follow-up. Planned mediator analyses included metacognitions, measured by the 65-item Meta-Cognition Questionnaire (MCQ),²⁵ and mindfulness, measured by the 39-item Five Facet Mindfulness Questionnaire (FFMQ),²⁶ assessed at weeks 0, 6, and 12. Safety included weekly adverse event tracking, strict guidelines for increased monitoring, and discontinuation criteria.²³

Statistical Analysis

Sample size was set by the noninferiority test of KY vs CBT. A total of 95 participants per group were needed for 0.80 power. The SE sample size was set at 40. For superiority tests, Monte Carlo simulations found 0.80 power to detect a difference in response rates (RRs) greater than 22% between the treatments and SE, assuming 25% missing data.

Analyses were conducted using HLM software, version 8.0 (Scientific Software International). Dropouts were compared with completers on baseline characteristics, controlling for

multiple comparisons using Benjamini-Hochberg adjustment. The primary outcome (response to treatment, yes or no) was analyzed using an intention-to-treat generalized linear mixed model (GLMM) with a logistic link function.²⁷ GLMM had 3 levels: repeated measurements nested within participants, who were nested within their treatment cohort (3-6 per cohort). Site was included as a covariate and as a moderator. The growth curve model for outcome over time was modeled as a quadratic function because RRs leveled off near the end of treatment. The growth curve for hypotheses 2.1 to 2.3 was modeled as piecewise, separately modeling treatment and follow-up. We used specific contrasts to test each hypothesis. Two-sided $P < .05$ was considered statistically significant.

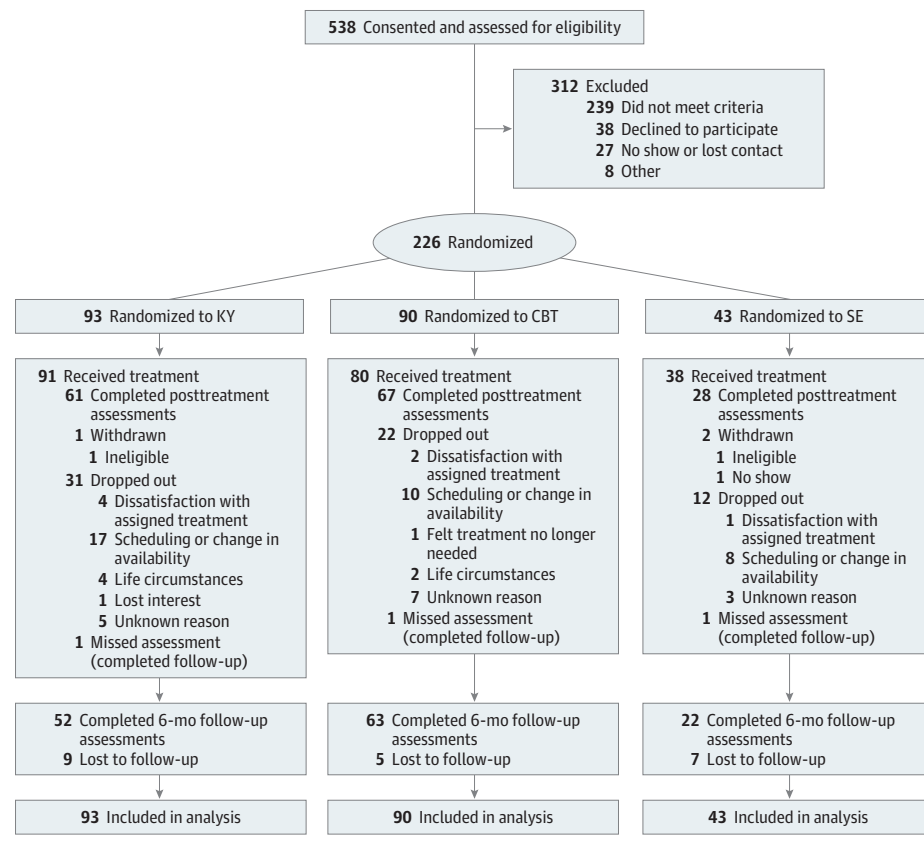
A priori sensitivity analyses used GLMM logistic regression, with posttreatment response as the dependent variable, treatment condition as the independent variable, and baseline severity as a covariate. Participants were nested within the treatment cohort (eMethods in Supplement 2). Noninferiority analyses were conducted for hypotheses 1.3 and 2.3 (KY noninferior to CBT). For noninferiority, the upper bound of the 1-sided 95% CI of the difference between treatments (RR in CBT minus RR in KY) must be less than the noninferiority margin (Δ). Before the trial began, Δ was set to 17.85%, which was 50% of the difference between the expected effect of the established treatment (CBT) and a control group.²

Longitudinal mediation analyses examined FFMQ and/or MCQ as treatment mediators (KY vs SE and CBT vs SE) at posttreatment assessment. Because time-varying predictors conflate between- and within-participant differences, we disaggregated each time-varying predictor into its between-participants component (mean level per person) and its within-participants deviations (eMethods in Supplement 2).²⁸

Results

Of 538 participants who provided consent and were evaluated, 226 (mean [SD] age, 33.4 [13.5] years; 158 [69.9%] female) with a primary diagnosis of GAD were randomized to receive KY (n = 93), CBT (n = 90), or stress education (n = 43) (Figure 1). Posttreatment assessments were completed by 155 (68.6%). These completer rates did not significantly differ across treatments (KY, 60 [64.5%]; CBT, 67 [74.4%]; SE, 28 [65.1%]; $\chi^2 = 2.39$, $df = 2$, $P = .30$), sex (female completers, 110 [69.6%]; male completers, 45 [66.2%]; Fisher exact test $P = .24$), race/ethnicity (race: $\chi^2 = 9.79$, $df = 5$, $P = .39$; ethnicity: Hispanic completers, 22 [78.6%]; non-Hispanic completers, 133 [67.2%]; Fisher exact test $P = .28$), educational level ($t = 1.17$, $df = 222$, $P = .24$), or income ($t = 1.00$, $df = 222$, $P = .32$). However, participants who dropped out tended to be younger (mean [SD] age, 31.1 [12.3] years) compared with participants who completed the study (mean [SD] age, 35.7 [14.3] years; $t = 2.57$, $df = 224$, $P = .07$). There was minimal dropout because of treatment dissatisfaction. The greatest reported challenge was scheduling. Six-month follow-up was completed by 137 (60.6%); follow-up completion rates did not significantly differ among the KY (52 [55.9%]), CBT (63 [70.0%]), and SE

Figure 1. CONSORT Flow Diagram



The trial was performed at 2 sites with randomization distribution within site as follows. Site 1: Kundalini yoga (KY), $n = 49$; cognitive behavior therapy (CBT), $n = 42$; and stress education (SE), $n = 24$. Site 2: KY, $n = 44$, CBT, $n = 48$; and SE, $n = 19$. All randomized participants were included in the primary analyses.

(22 [51.2%]) groups ($\chi^2 = 4.49$, $df = 2$, $P = .11$). The Table presents the baseline characteristics.

Primary Outcome: Posttreatment Response

Response rates at the posttreatment assessment were higher in the KY (54.2%) vs the SE group (33.0%) (odds ratio [OR], 2.46 [95% CI, 1.12-5.42]; $t = 2.22$, $df = 37$, $P = .03$; number needed to treat, 4.59 [95% CI, 2.52-46.19]) (Figure 2). Response rates were also higher in the CBT (70.8%) vs the SE group (33.0%) (OR, 5.00 [95% CI, 2.12-11.82]; $t = 3.64$, $df = 37$, $P < .001$; number needed to treat, 2.62 [95% CI, 1.91-5.68]).

For KY to be noninferior to CBT (hypothesis 1.3), the entire 1-sided 95% CI of the difference between CBT (70.8%) and KY (54.2%) must be below the noninferiority margin (Δ), which was set at 17.85% (0.1785). Although the raw RR difference between CBT and KY (RR in CBT minus RR in KY) was only 16.6% (0.166), the entire 1-sided 95% CI of the difference between CBT and KY was minus infinity to 0.28. Thus, the upper bound of the 95% CI for the difference between treatments exceeded Δ , and we cannot conclude that KY was noninferior to CBT at posttreatment assessment. Conversely, we were unable to conclude that the RR of CBT was significantly higher than KY (OR, 0.49; 95% CI, 0.24-1.03; $t = -1.87$, $df = 37$, $P = .07$) in a test of superiority.

In the eMethods in the Supplement 2, we report details of planned sensitivity analyses (a completer analysis and an analysis using last observation carried forward) investigating

RR at posttreatment assessment. We also report results for the slopes of improvement in RRs in the primary GLMM analysis. All 3 analyses indicated that CBT was superior to both SE and KY and did not find significant differences between KY and SE.

Secondary Outcome: Response at 6-Month Follow-up

At 6-month follow-up, the CBT RR (76.7%) was higher than that of SE (48.0%) (OR, 3.56 [95% CI, 1.08-11.70]; $t = 2.09$, $df = 37$, $P = .04$; number needed to treat, 3.51 [95% CI, 2.30-50.80]), whereas the KY RR (63.2%) was not significantly higher than that of SE (OR, 1.86; 95% CI, 0.52-6.69; $t = 0.96$, $df = 37$, $P = .34$). We were also unable to detect an RR difference between KY and CBT (OR, 1.91; 95% CI, 0.69-5.26; $t = 1.24$, $df = 37$, $P = .22$) in a superiority test. In the noninferiority test, the CBT and KY RR difference was 13.5%, but the upper bound of the 1-sided 95% CI for this difference (minus infinity to 0.24) exceeded Δ (0.1785). Thus, we cannot conclude that KY was noninferior to CBT at follow-up.

Because there were potentially important clinical differences in rates of depression at baseline for CBT vs KY (25.6% vs 12.9%) and in medication use during follow-up (24.4% vs 3.2%), we examined depression and medication as potential covariates and/or moderators of treatment group differences. Neither accounted for differences between groups or moderated outcomes at the posttreatment or follow-up assessment.

Table. Sample Characteristics^a

| Characteristic | KY (n = 93) | CBT (n = 90) | SE (n = 43) |
|---|----------------|-----------------|----------------|
| Demographics | | | |
| Age, mean (SD), y | 32.6 (13.3) | 35.1 (13.8) | 31.6 (13.3) |
| Male | 26 (28.0) | 28 (31.1) | 14 (32.6) |
| Race/ethnicity | | | |
| White (non-Hispanic) | 68 (73.1) | 63 (70.0) | 29 (67.4) |
| White (Hispanic) | 11 (11.8) | 6 (6.7) | 1 (2.3) |
| Black | 3 (3.2) | 5 (5.6) | 3 (7.0) |
| Asian/Pacific Islander | 8 (8.6) | 8 (8.9) | 5 (11.6) |
| Other | 3 (3.2) | 8 (8.9) | 5 (11.6) |
| Educational level^b | | | |
| High school or less | 1 (1.1) | 1 (1.1) | 3 (7.1) |
| Technical school or some college | 14 (15.2) | 14 (15.6) | 4 (9.5) |
| College graduate | 37 (40.2) | 44 (48.9) | 18 (42.9) |
| Graduate or professional school (some or completed) | 40 (43.5) | 31 (34.4) | 17 (40.5) |
| Marital status^b | | | |
| Single, never married | 59 (64.1) | 43 (47.8) | 22 (52.4) |
| Married | 17 (18.5) | 34 (37.8) | 11 (26.2) |
| Living with partner | 12 (13.0) | 10 (11.1) | 7 (16.7) |
| Other | 4 (4.3) | 3 (3.3) | 2 (4.8) |
| Current employment^b | | | |
| Full-time (>35 h/wk) | 43 (47.3) | 46 (51.1) | 23 (54.8) |
| Part-time (<35 h/wk) | 21 (23.1) | 16 (17.8) | 7 (16.7) |
| Other | 27 (29.7) | 28 (31.1) | 12 (28.6) |
| Past employment^b | | | |
| Most or all of the time | 61 (67.0) | 61 (68.5) | 28 (66.7) |
| Some of the time (up to half) | 15 (16.5) | 14 (15.7) | 7 (16.7) |
| Briefly or not at all | 15 (16.5) | 14 (15.7) | 7 (16.7) |
| Income^b | | | |
| Prefer not to say | 18 (19.6) | 16 (17.8) | 6 (14.3) |
| \$0-\$24 999 | 28 (30.4) | 19 (21.1) | 13 (31.0) |
| \$25 000-\$74 999 | 31 (33.7) | 38 (42.2) | 15 (35.7) |
| >\$75 000 | 15 (16.3) | 17 (18.9) | 8 (19.0) |
| Comorbid psychiatric diagnoses (>5% prevalence) | | | |
| Social anxiety disorder | 45 (48.4) | 36 (40.0) | 17 (39.5) |
| Major depressive disorder | 12 (12.9) | 23 (25.6) | 8 (18.6) |
| Specific phobia ^b | 15 (16.1) | 19 (21.3) | 7 (16.3) |
| Panic | 13 (14.0) | 7 (7.8) | 3 (7.0) |
| Dysthymia | 10 (10.8) | 4 (4.4) | 2 (4.7) |
| Agoraphobia | 8 (8.6) | 5 (5.6) | 2 (4.7) |
| Other axis 1 disorder | 6 (6.5) | 7 (7.8) | 2 (4.7) |
| No. of comorbid psychiatric diagnoses | | | |
| 0 | 33 (35.5) | 28 (31.1) | 15 (34.9) |
| 1 | 28 (30.1) | 35 (38.9) | 18 (41.9) |
| 2 | 20 (21.5) | 18 (20.0) | 8 (18.6) |
| ≥3 | 12 (12.9) | 9 (10.0) | 2 (4.7) |
| Psychotropic medication use | | | |
| At least 1 during the treatment phase | 4 (4.30) | 10 (11.11) | 1 (2.33) |
| At least 1 during 6-mo follow-up phase | 3 (3.23) | 22 (24.4) | 1 (2.33) |

Abbreviations: CBT, cognitive behavioral therapy; KY, Kundalini yoga; SE, stress education.

^a Data are presented as number (percentage) of participants unless otherwise indicated.

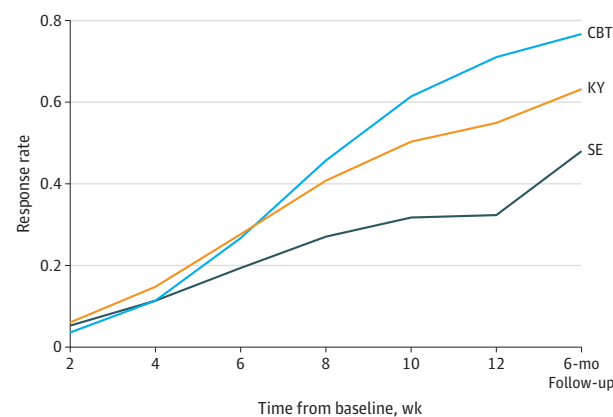
^b Data are missing for educational level, marital status, and income (n = 2); current employment (n = 3); past employment (n = 4); and DSM-5 specific phobia (n = 1).

Mediation of Treatment Effects

Mediation analyses investigated whether changes in FFMQ and/or MCQ mediated the significant treatment condition dif-

ferences between KY and SE and between CBT and SE at post-treatment assessment (Figure 3 and eMethods in Supplement 2). Only 1 “a” path was significant (a_4), indicating that

Figure 2. Change in Treatment Response Rate Over Time



Response rates are based on a Clinical Global Impressions-Improvement Scale score of 1 or 2. CBT indicates cognitive behavioral therapy; KY, Kundalini yoga; and SE, stress education.

decreases in MCQ were greater in CBT than SE ($b = -8.01$; 95% CI, -0.36 to -2.66 ; $t = -2.94$, $df = 37$, $P = .006$) (Figure 3). All the “b” paths were significant. Greater increases in FFMQ were associated with greater RRs ($b = 0.08$ [95% CI, 0.03-0.13]; $t = 2.85$, $df = 39$, $P = .007$; OR, 1.08 [95% CI, 1.03-1.14]), and greater increases in MCQ (worse MCQ) were associated with lower RRs ($b = -0.03$ [95% CI, -0.01 to -0.05]; $t = -3.00$, $df = 39$, $P = .005$; OR, 0.97 [95% CI, 0.95-0.99]). Similarly, participants with higher mean levels of FFMQ ($b = 0.03$ [95% CI, 0.01-0.05]; $t = 3.02$, $df = 148$, $P = .003$; OR, 1.03 [95% CI, 1.01-1.05]) and lower mean levels of MCQ ($b = -0.002$ [95% CI, -0.01 to 0.03]; $t = 2.94$, $df = 148$, $P = .004$; OR, 0.98 [95% CI, 0.97-0.99]) were more likely to be responders. Mediation analyses indicated that changes in MCQ partially mediated the greater response to treatment in CBT vs SE at posttreatment assessment ($a \times b = 0.24$; 95% CI, 0.001-0.64), and accounted for 15% of the RR difference.

Patient Safety, Treatment Adherence, and Interrater Reliability

All 3 treatments were well tolerated (eTable in the Supplement) with no related serious adverse events. One serious adverse event, unrelated to treatment, occurred (hospitalization for infection in the CBT group). At least 1 adverse event rated at least possibly related to treatment was reported in 6.5% of KY participants (3 joint pain, 1 tingling, and 1 vertigo), 4.4% of CBT (3 anxiety, 2 bulimia episodes, and 1 depression), and 2.3% of SE (1 anxiety).

Treatment adherence and competency was evaluated by 2 independent fidelity evaluators, including one of us (E.H.) assessing a random 22% (114; target 15%) of treatment sessions. Good or excellent ratings (on 5-point scale of 0, indicating poor, to 4, indicating excellent) were high for both adherence (KY, 45 of 49 [91.8%]; CBT, 40 of 44 [90.9%]; and SE, 20 of 21 [95.2%]) and competence (KY, 47 of 49 [95.9%]; CBT, 43 of 44 [97.7%]; and SE, 20 of 21 [95.2%]). Interrater reliability for key clinical assessments (weeks 6, 12, and 36) was evaluated by 19 independent evaluators (study cumulative) on a

random 91 recorded assessments (19.0%). Interrater reliability assessing responder status indicated strong rater agreement (Fleiss $\kappa = 0.89$; 95% CI, 0.83-0.96; Gwet AC1 = 0.90; 95% CI, 0.83-0.98, with an a priori goal of ≥ 0.80).²⁹

Discussion

This RCT of adults with GAD found that group CBT was more effective than a previously validated active control condition (SE) matched for time and instructor contact. The CBT RR was 70.8% compared with 33.0% for SE. As hypothesized, KY also had a greater short-term RR (54.2%) than SE, supporting the anxiolytic effects of yoga for patients with a primary diagnosis of GAD. In contrast to our hypotheses, however, we failed to find KY noninferior to CBT, although superiority analyses did not conclusively indicate greater short-term CBT efficacy.

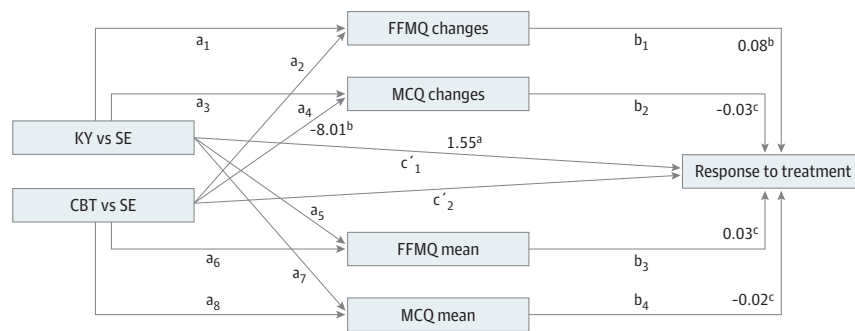
Long-term outcome and planned sensitivity analyses found greater efficacy of CBT compared with SE across several alternative modeling approaches at 6-month follow-up. In contrast, KY RRs were between those of CBT and SE and were significantly better than SE only in the primary posttreatment analysis but not in any of the sensitivity or follow-up analyses. This finding suggests a less robust KY effect. Furthermore, directly comparing CBT and KY, we did not find KY to be noninferior to CBT at posttreatment assessment or 6-month follow-up, and planned completer and last observation carried forward sensitivity analyses found CBT to be more effective than KY at posttreatment assessment. Overall, this finding confirms the effectiveness of group CBT for GAD as a first-line treatment. Although not conclusive, results also suggest that KY may have some short-term anxiolytic efficacy for some individuals, but these effects may be less strong or persistent.

Our finding is in line with a recent small RCT that reported that 8 weeks of KY was associated with lower anxiety compared with treatment as usual among women with GAD¹⁴ and with prior data suggesting that mindfulness-based interventions incorporating elements of yoga may be efficacious for GAD.¹² That the KY effect was less robust, however, is also consistent with a recent meta-analysis of 8 yoga RCTs (pooled $n = 319$) that called for more high-quality research with formal diagnostic assessments after finding promising but inconclusive anxiolytic effects.⁷ Overall, the available literature and our data support that KY may be a helpful but only moderately potent intervention for GAD.

Given the increasing costs of health care and barriers to accessing trained mental health care professionals, however, yoga may still have a role to play in GAD management as an intervention that is more easily accessible. Future studies should identify individual characteristics that make a patient more prone to respond to yoga vs CBT, including treatment preference and attitudes toward mental health care, which could inform how yoga might be integrated into a stepped-care personalized approach to anxiety disorders.

Mediation analyses found that mindfulness (FFMQ) and metacognitions (MCQ) were associated with response across treatments. Consistent with our hypothesis, differences between CBT and SE response rates were partially mediated by

Figure 3. Mediation Model



Response rates are based on a Clinical Global Impressions-Improvement Scale score of 1 or 2. Mean refers to the mean of that questionnaire over all its assessments during the treatment phase. Changes refer to the deviation of scores on that questionnaire from the mean on that questionnaire at each assessment point. We did not examine the mean level of Five Facet Mindfulness Questionnaire (FFMQ) or Metacognitions Questionnaire (MCQ) as mediators because mean levels were confounded by the third variable between-

participant differences. Only significant path coefficients are shown. Absent path coefficients were not significant. CBT indicates cognitive behavioral therapy; KY, Kundalini yoga; and SE, stress education.

^a $P < .05$.

^b $P < .01$.

^c $P < .005$.

changes in metacognitions, but metacognitions did not significantly mediate differences between KY and SE. We were unable to detect mediation of active treatments (KY and CBT) via changes in mindfulness. Greater mindfulness was associated with better treatment response, but the active treatments did not increase mindfulness significantly more than SE did. It is unclear why we did not detect a greater effect of KY on mindfulness compared with SE. Mindfulness has been highlighted as a potential mediating factor in yoga's effects,^{17,18} and long-term yoga practice has been correlated with increased mindfulness.^{19,20} Some, but not all, yoga studies^{30,31} have found increases in mindfulness. One possible reason is that KY predominantly focuses attention on a single target, such as a mantra or breathing, rather than open-focus mindfulness, as done with Kripalu yoga.³¹ Another possibility could be related to limitations of the FFMQ measure that might inadequately measure the construct, lacking external validity.³² Additional GAD studies might examine the effects of yoga compared with other interventions that target mindfulness, such as mindfulness-based stress reduction.¹²

Strengths and Limitations

Strengths of this study include its rigorous design, including balanced time and attention in each condition, independent clinical raters with high interrater reliability, and formalized training, certification, cross-site supervision, and adherence

procedures that resulted in high adherence across interventions. There are also some limitations. First, these rigorous procedures in academic centers may not fully generalize to the way yoga and CBT are delivered in the community; however, this study was designed to answer best-case relative efficacy questions. Future work could use a community-based effectiveness design. Second, KY findings may not fully generalize to all yoga types. We chose KY based on our clinical and pilot experience with anxiety^{14,15} and because it is a traditional multicomponent yoga practice. Hence, it is more likely to be effective as therapy than predominantly physical or postural yoga practices.^{11,33,34} Third, our mediation analysis examined the concurrent association between the mediators and outcome rather than the lagged association between the 2. Thus, although our mediation analysis is consistent with MCQ mediating the effect of CBT vs SE on response, it does not provide a conclusive test of mediation.

Conclusions

This trial suggests that KY has less consistent or robust efficacy for GAD compared with CBT, which remains a first-line treatment for GAD. Future research is needed to better understand individual differences in the heterogeneity of response to yoga and CBT.

ARTICLE INFORMATION

Accepted for Publication: June 10, 2020.

Published Online: August 12, 2020.
doi:10.1001/jamapsychiatry.2020.2496

Author Contributions: Drs Simon and Hofmann contributed equally to this work. Drs Simon and Hofmann had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.
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Acquisition, analysis, or interpretation of data: Simon, Hofmann, Rosenfield, Hoepfner, Hoge, Bui.
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Critical revision of the manuscript for important intellectual content: All authors.
Statistical analysis: Hofmann, Rosenfield, Hoepfner.
Obtained funding: Simon, Hofmann, Rosenfield, Khalsa.
Administrative, technical, or material support: Simon, Hofmann, Hoepfner, Hoge, Bui, Khalsa.

Supervision: Simon, Hofmann, Hoge, Bui, Khalsa.

Conflict of Interest Disclosures: Dr Simon reported receiving grants from the National Institutes of Health (NIH) during the conduct of the study; receiving grants from the US Department of Defense, American Foundation for Suicide Prevention, Patient-Centered Outcomes Research Institute, Highland Street Foundation, and Janssen; receiving personal fees from Vanda, Axovant Sciences, Springworks, Praxis Therapeutics, Aptinix, Genomind, Wiley, and the Massachusetts General Hospital (MGH) Psychiatry Academy;

performing grant reviews for American Foundation for Suicide Prevention; receiving royalties for UpToDate contributions from Wolters Kluwer; and having spousal stock from GI Therapeutics outside the submitted work. Dr Hofman reported receiving grants from the National Center for Complementary and Integrative Health (NCCIH), NIH during the conduct of the study. Dr Rosenfield reported receiving grants and personal fees from the NCCIH, NIH during the conduct of the study. Dr Hoepfner reported receiving grants from the NCCIH, NIH and nonfinancial support from Mark Pollack during the conduct of the study and receiving grants from the American Cancer Society, the Executive Committee on Research at MGH, Telefonica Alpha Inc, and National Institute on Drug Abuse outside the submitted work. Dr Hoge reported receiving grants from the NIH during the conduct of the study. Dr Bui reported receiving grants from the NIH during the conduct of the study and receiving royalties from Springer and grants from the US Department of Defense, Osher Center for Integrative Medicine, and Elizabeth Dole Foundation outside the submitted work. Dr Khalsa reported receiving grants from the NCCIH, NIH during the conduct of the study; receiving grants and personal fees from Kundalini Research Institute and grants from Kripalu Center for Yoga & Health outside the submitted work; and being a practitioner and certified instructor in Kundalini yoga as taught by Yogi Bhasan.

Funding/Support: This study was funded by grants 1R01AT007258 and 1R01AT007257 from the NCCIH, NIH (Drs Simon and Hofmann).

Role of the Funder/Sponsor: The NCCIH representatives gave feedback on the design and conduct of the study before study initiation and used a study monitor during the study. The NCCIH played no role in the collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Data Sharing Statement: See Supplement 3.

Additional Contributions: We thank the practitioners, raters, research assistants, and study participants involved in this trial.

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