HHS Public Access

Author manuscript

Cogn Behav Ther. Author manuscript; available in PMC 2025 November 26.

Published in final edited form as:

Cogn Behav Ther. ; : 1–12. doi:10.1080/16506073.2025.2589392.

Impact of homework engagement on treatment response to group cognitive-behavioral therapy, yoga, and stress education for generalized anxiety disorder

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Abstract

Homework is a potential contributor to treatment response in cognitive-behavioral therapy (CBT) for anxiety, but less is known regarding the importance of yoga homework for generalized anxiety disorder (GAD). This study examined the impact of homework engagement on treatment response within a randomized controlled trial (RCT) of 12 weeks of group CBT, Kundalini Yoga (KY), or stress education (SE) in a subsample of 190 adults with GAD (71% female, Mean age = 33 ± 13) who attended ≥2 sessions and submitted ≥1 homework log. Participants in CBT and KY

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showed greater overall homework engagement than those in SE (ps < .05). Across treatment arms, staff-rated homework compliance (p = .002, OR = 1.74), but not participant-reported days per week engaged in homework (p = .108), predicted clinical response at post-treatment ("response"). Greater staff-rated homework compliance was related to a greater response for those in CBT (p = .005, OR = 2.49) and KY (p = .049, OR = 1.66), but not SE. Greater participant-reported homework days per week was only marginally related to response to CBT (p = .054, OR = 1.71), and was not related to response to KY or SE. These findings highlight the importance of homework engagement in CBT for GAD. More research is needed to further elucidate the role of homework engagement in yoga for GAD. TRIAL REGISTRATION: clinicaltrials.gov: NCT01912287; https://clinicaltrials.gov/ct2/show/NCT01912287

Keywords

Generalized anxiety disorder; anxiety; cognitive behavioral therapy; yoga; homework

Introduction

Generalized anxiety disorder (GAD) is a common and impairing psychiatric condition, characterized by difficult-to-control and excessive worry across several domains (Ruscio et al., 2017). Cognitive-behavioral therapy (CBT) is a first-line psychotherapy that improves symptoms (Carpenter et al., 2018) and quality of life (Hofmann et al., 2014) for adults with GAD, including CBT in group formats (Barkowski et al., 2020). However, only one-third of individuals with GAD access specialty mental healthcare (Ruscio et al., 2017), whereas yoga is an increasingly popular community intervention with growing evidence as a treatment for anxiety and related conditions including GAD (Cramer et al., 2018; Simon et al., 2021). In our randomized controlled trial (RCT) of group CBT, Kundalini Yoga (KY), and stress education (SE) in 226 adults with GAD, treatment response (response) rates were higher in CBT (70.8%) and KY (54.2%) compared to SE (33%), though KY was not found non-inferior to CBT. All three interventions were delivered weekly to groups of 3 to 6 participants with 20 minutes of daily assigned homework between sessions, providing the opportunity to examine the important question of how homework engagement impacts outcome in these efficacious specialty and community-based interventions.

Homework, defined as practice assignments related to a topic presented in a therapy session to be completed between sessions, is a potential contributor to response that has generally been supported by empirical studies. Kazantzis and colleagues (Kazantzis et al., 2010) found that psychotherapies that employ homework demonstrate larger treatment effects compared to those that do not. Homework engagement, a comprehensive concept that includes measures of homework compliance, quantity completed, quality and skill acquisition (Kazantzis & Miller, 2022), has also been associated with response. A meta-analysis of studies including predominantly CBT interventions found that homework engagement was positively associated with treatment outcome for patients in general (r = .26), and for those with anxiety disorders in particular (r = .22) (Mausbach et al., 2010), although only two studies (pooled n = 91) focused on patients with GAD (Westra et al., 2007; Wetherell et al., 2005). A recent RCT comparing a transdiagnostic CBT protocol with four single-diagnosis

CBT protocols for adults with anxiety disorders (n = 62 adults with GAD) found that homework compliance and homework quality related to treatment response (Conklin et al., 2021).

Less is known regarding the effects of homework for yoga interventions. One meta-analysis of 17 studies of Hatha yoga for anxiety (pooled n = 501) found that treatment efficacy was moderated by the total number of hours practiced ($p < 0.05$) and number of sessions per week ($p < 0.001$) (Hofmann et al., 2016). A meta-analysis of mindfulness-based interventions (which included stretching with mindful attention exercises that have similar components to yoga) for psychiatric disorders reported an association between homework quantity and response that was similar in strength to that reported for CBT (r = .26) (Parsons et al., 2017). As yoga becomes an increasingly popular health-related intervention (Davies et al., 2024), rigorous RCT data is needed to characterize how homework engagement relates to anxiety symptom improvement. Because yoga homework is different in nature from CBT homework, the most appropriate homework engagement measures to use in a yoga context also require further attention. For example, it may be easier for staff to accurately rate a homework compliance-scale measure based on a review of submitted CBT homework than based on a participant's account of a KY practice completed at home. Alternatively, it may be easier for participants to accurately recall the frequency with which they completed KY home practice (which involved timed practice on a mat with a specific audio recording) than the frequency of CBT home practice, which can include brief mental acts that are integrated into their day-to-day lives. Thus, a homework compliance scale may better measure engagement with CBT homework and practice quantity or frequency may better reflect engagement with KY homework.

The current study is a secondary exploratory analysis examining the association between homework and response within an RCT comparing group CBT, KY, and SE for adults with GAD. We utilized two metrics of homework engagement: 1) staff-rated homework compliance, and 2) self-reported days per week of homework (from homework logs). We examined the relationship between each homework measure and response, as predictors of response across treatment arms, predictors of response within treatment arms, and as moderators of differences in response between treatment arms.

Methods

Study design

This is a secondary data analysis of a multi-site RCT of 226 adults with a primary diagnosis of GAD randomized to one of three 12-session weekly group interventions (CBT (n = 90), KY (n = 93), or SE (n = 43); Generalized Anxiety-A Treatment Evaluation [GATE]; clinicaltrials.gov identifier: NCT01912287). The present analysis included the 190 participants who attended two or more intervention sessions (since they had an opportunity to submit at least one homework log) and who submitted at least one homework log. Primary trial methods including exclusion criteria (Hofmann et al., 2015) and primary outcomes (Simon et al., 2021) are published elsewhere. The study was approved by the Institutional Review Boards at the recruiting sites. Written informed consent was obtained from all participants prior to enrollment.

Interventions

Details of the three interventions are published (Hofmann et al., 2015; Simon et al., 2021). Briefly, 120-min sessions with groups of 3 to 6 members led by 2 instructors were conducted weekly for 12 weeks. Instructors were trained and certified, and ongoing supervision was provided by expert investigators. CBT included: (1) goal setting, motivation, and psychoeducation, (2) progressive muscle relaxation, (3) cognitive restructuring, (4) meta-cognitive strategies, (5) worry exposures, (6) behavioral changes, and (7) goal evaluations and relapse prevention. CBT homework included activities and worksheets that prompted participants to practice the skills introduced in sessions. KY included physical postures, breathing techniques, relaxation exercises, and meditation practices. KY homework prompted participants to complete an audio-guided sequence of movements coordinated with the breath, followed by timed breathing, while practicing mindful awareness. The same audio-guided sequence was utilized for each homework session. SE involved education on stress, resilience, diet, exercise, and other lifestyle factors and functioned as a standardized active control condition. SE homework involved listening to audio recordings about nutrition and positive perspectives on lifestyle and emotions. Homework prescriptions were standardized across treatments at 20 minutes per day and assigned weekly at sessions 1 through 11.

Measures

Homework engagement measures: In one homework measure, participants were instructed to record the number of days (regardless of amount of time per day) spent engaged in homework each week on a written log submitted in person at each weekly session. The self-report measure of average homework days per week consists of the number of days engaged in homework per week averaged across the study for each participant. The other measure of homework engagement is based on weekly study staff (non-therapist) interviews with participants reviewing the homework they completed as well as their homework log. Study staff rated homework compliance on a weekly basis using a standardized homework compliance scale (Leung & Heimberg, 1996; Primakoff et al., 1986), consisting of a 0–6 point Likert scale with anchored ratings of 0 (did not complete any assignments/practices), 3 (moderate completion [completed only some assignments/practices]), and 6 (completed all assignments/practices). Only 1.5% ($n = 3$) of the participants who attended two or more sessions did not submit a homework log. Amongst the included participants, 34% (23% in CBT; 26% in KY; 49% in SE) dropped out prior to session 12. The drop-out occurred after session 10 on average. For both homework measures, the average value for the weeks in which they reported homework was used. Below, the term “homework engagement” refers to both homework measures.

Treatment outcome: Response was assessed with a clinician-rated CGI-Improvement measure (CGI-I). The CGI-I compares the participant’s overall clinical condition to their prior condition during the 1-week period leading up to their baseline visit. One question is rated on a 7-point scale: “Compared to the patient’s condition at baseline, this patient’s condition is: 1 = very much improved since the initiation of treatment; 2 = much improved; 3 = minimally improved; 4 = no change from baseline (the initiation of treatment); 5 = minimally worse; 6 = much worse; 7 = very much worse since the initiation of treatment

(Busner & Targum, 2007). Response was defined by a CGI-I score of either 1 (very much improved) or 2 (much improved) in accordance with the pre-specified primary outcome and published manuscript (Simon et al., 2021). Response was coded as a binary variable (0 = non-responder; 1 = responder) and assessed every 2 weeks during treatment (weeks 2, 4, 6, 8, 10, and 12; CGI-I cannot be assessed at baseline, week 0).

Data analysis

Baseline characteristics for the included $n = 190$ sample are reported. Average homework compliance ratings and average homework days per week were compared between treatment groups using ANOVA. Tukey's B was used for post-hoc multiple comparison adjustments for same-level effects within each model. Generalized linear mixed models (GLMM) were used to examine the effect of homework on response at post-treatment. Since the treatment response was a dichotomous variable, a logistic linking function and a binomial distribution were used. The GLMM was a 3-level model with the 6 assessments of response as level-1, which were nested within participants (level-2), which were nested within the treatment group. Predictors in the GLMM included Time (weeks from baseline, centered at week 12 [post-treatment]), Treatment Group (the 3 groups were coded with 2 dummy variables, one contrasting CBT to SE and the other contrasting KY to SE), and the interactions between Time X Treatment Group (CBT and KY being dummy coded). In addition, each operationalization of homework engagement (average homework compliance rating, average homework days per week) was added as a moderator of all these effects, each in separate GLMM analyses. The two homework engagement variables were z-scored to allow rough comparisons between their effects. Also, since the main effects of interactions (and all subcomponent interactions of higher-order interactions) are dependent on the coding of the variables in the higher-order interactions, the dummy coded treatment group variables were coded differently across different simple slope analyses to yield the desired main effects and interactions for a certain group, or the average of the groups (Aiken & West, 1991). For example, the dummy coded treatment group variables were each z-scored in analyses so that sub-components of interactions involving these variables (e.g. the main effects of homework and the homework × Time interactions) would reflect effects for the average participant. In other simple slope analyses, these treatment group dummy variables were coded so that the group of interest was coded "0", thus yielding main effects and subcomponent interactions (e.g. the main effect of homework and the homework × Time interaction) that reflected those effects for the group of interest. Finally, the number of treatment sessions attended was included as a control variable in all analyses. Exploratory analyses also investigated whether the number of treatment sessions attended moderated the effect of homework engagement on response at post-treatment. In these analyses, the interactions between treatment sessions and each of the predictors of response in our primary analyses were added to the primary analyses described above, up to the 4-way interaction between treatment group, time, homework, and treatment sessions attended. These secondary analyses did not adjust for site, which was not found to be a significant predictor of outcomes in the main analysis (Simon et al., 2021). All analyses were completed using IBM SPSS 29.0, and the level of statistical significance was set to 0.05 (two-tailed). Odd ratios (ORs) are reported for effect sizes.

Results

Baseline sample characteristics

All 190 participants (84% of full randomized sample) who attended at least two treatment sessions and submitted at least one homework log were included in analyses. Baseline characteristics are in Table 1. Treatment groups differed on one of the six baseline characteristics (current major depressive disorder (MDD); $\chi^2(2) = 8.4$, $p = .015$), with the rate of current MDD being 25.3% in CBT, 7.9% in KY, and 20.0% in SE. Given this baseline difference, sensitivity analyses were conducted controlling for baseline current MDD.

Average homework

Participants were rated to have moderate homework compliance on average (3.60 ± 1.28 out of 6) and reported performing homework on approximately half of the six assigned days per week (2.86 ± 1.36). ANOVAs showed that the 3 treatment groups differed on average homework compliance scores (F(2, 187) = 7.48, $p = .010$) and on average homework days per week (F(2, 187) = 5.52, $p = .005$). Tukey's B post-hoc multiple-comparison tests indicated that both the CBT and KY groups received higher average homework compliance staff ratings than SE (CBT: 3.84 ± 1.06 points; KY: 3.61 ± 1.34 points; SE: 3.06 ± 1.49 points). Tukey's B also indicated that participants assigned to CBT (3.06 ± 1.33 days per week) and to KY (2.97 ± 1.38 days per week) averaged more homework days per week than participants assigned to SE (2.19 ± 1.22 days per week). CBT and KY did not significantly differ on average homework compliance ratings or on average homework days per week. Average homework compliance scores and average homework days per week were strongly correlated (r(188) = .76, $p < .001$). Both homework measures were also correlated with session attendance (average homework compliance: r(188) = .15, $p = .047$; average homework days per week: r(188) = .35, $p < .001$).

Impact of homework on treatment response at post-treatment

The GLMM showed that, on average across the 3 treatment groups, higher average staff-rated homework compliance scores were significantly related to greater odds of treatment response at post-treatment ($b = .56$, $t(914) = 3.10$, $OR = 1.74$, *95%CI*: [1.23, 2.48], $p = .002$). Average number of self-reported homework days per week was not significantly related to treatment response at post-treatment ($p = .108$). For complete GLMM results, see Table 2.

The effects of our two measures of homework engagement on response at post treatment differed by treatment group. Simple slopes analyses (Aiken & West, 1991), using the same models reported in Table 2 but recoding the treatment group dummy variables to yield effects for specific treatment groups, showed that, for average staff-rated homework compliance, greater homework compliance was related to greater odds of treatment response for those in CBT ($b = .91$, $t(914) = 2.81$, $OR = 2.49$, *95%CI*: [1.32, 4.71], $p = .005$) and in KY ($b = .51$, $t(914) = 1.97$, $OR = 1.66$, *95%CI*: [1.001, 2.75], $p = .049$), but not for those in SE ($p = .802$; see Figure 1a). The relation between homework compliance and response was significantly greater in CBT than in SE ($b = .99$, $t(914) = 2.21$, $OR = 2.69$, *95%CI*:

[1.12, 6.46], $p = .027$), but not in KY vs. SE ($p = .145$), or for CBT vs. KY ($p = .322$). As can be seen in Figure 1a, there were no differences between treatments (ps > .39) for participants with low levels of average staff-rated homework compliance (1SD below the mean, equivalent to a raw score of 2.32). However, for participants with high homework compliance (1SD above the mean, raw score = 4.88), those in CBT had significantly higher response rates than those in SE ($b = 2.50$, $t(914) = 3.34$, *OR* = 12.17, *95%CI*: [2.81, 52.81], $p < .001$) and those in KY had marginally higher response rates than those in SE ($b = 1.41$, $t(914) = 1.93$, *OR* = 4.11, *95%CI*: [.98, 17.24], $p = .054$).

Similar relationships were found using self-reported average homework days per week, but the relationships between homework days and response were not as strong (see Figure 1b). More days of homework was marginally related to greater response to treatment for those receiving CBT ($b = .54$, $t(914) = 1.93$, *OR* = 1.71, *95%CI*: [.99, 2.96], $p = .054$), and was positively, but non-significantly, related to response for participants in KY ($b = .40$, $t(914) = 1.62$, *OR* = 1.50, *95%CI*: [.92, 2.45], $p = .106$). On the other hand, the relation between days of homework and response was negative, but non-significant, in SE ($b = -.52$, $t(914) = -1.17$, *OR* = .60, *95%CI*: [.25, 1.42], $p = .242$). The relation between homework days and response was significantly greater in CBT than in SE ($b = 1.06$ $t(914) = 2.01$, *OR* = 2.88, *95%CI*: [1.03, 8.06], $p = .045$), and was marginally greater in KY vs. SE ($b = .92$, $t(914) = 1.82$, *OR* = 2.52, *95%CI*: [.93, 6.80], $p = .069$), but not for CBT vs. KY ($p = .717$). As can be seen in Figure 1b, there were no differences between treatments (ps > .23) for participants with low levels of self-reported days of homework (1SD below the mean, equivalent to 1.5 days per week). However, for participants with high levels of self-reported days of homework (1SD above the mean, 4.22 days per week), those in CBT had significantly higher response rates than those in SE ($b = 2.82$, $t(914) = 3.12$, *OR* = 16.68, *95%CI*: [2.84, 98.07], $p = .002$) and those in KY had significantly higher response rates than those in SE ($b = 1.91$, $t(914) = 2.15$, *OR* = 6.74, *95%CI*: [1.18, 38.59], $p = .032$).

Sensitivity analyses first examined whether results differed if we did not control for the number of sessions completed. These analyses yielded the same significant (and nonsignificant) effects as our primary analysis. Second, adding baseline current MDD as a covariate in the models did not change the results meaningfully. Current MDD was not significantly related to response (ps > .128), and compared to the results from the primary analysis above, one marginally significant ($p = .054$) result became significant ($p = .046$ for the relation between homework days per week and response for those in CBT), and one significant result ($p = .049$) became marginal ($p = .074$ for the relation between homework compliance and response for those in KY). Finally, the interaction between homework days per week and CBT vs. SE went from $p = .045$ to $p = .050$.

Exploratory analyses

Treatment session attendance moderating effect of homework engagement on treatment response: Exploratory analyses showed that the number of treatment sessions attended ($M = 8.79$, SD = 2.97 out of 12) moderated the effects of both average staff-rated homework compliance and average self-reported homework days per week on response, but only for those in CBT. Higher session attendance was associated with a reduced effect of

homework compliance and homework days per week on response for participants in CBT (b = −1.54, t(903) = −2.23, *OR* = .21, *95%CI*: [.06, .83], p = .026, and b = −1.09, t(903) = −2.03, *OR* = .34, *95%CI*: [.12, .97], p = .043, respectively), but not for those in KY or SE (ps > .224). Across treatment groups, for those who attended the mean number of sessions (8.8) or less, greater homework compliance was significantly related to higher response (b = 1.42, t(903) = 2.72, *OR* = 4.12, *95%CI*: [1.48, 11.43], p = .007), as was more homework days (b = .96, t(903) = 2.04, *OR* = 2.62, *95%CI*: [1.04, 6.62], p = .041). For those who completed many sessions (e.g. 11 sessions or more for homework compliance, 10 sessions or more for homework days per week); however, greater homework compliance was not related to response (b = .27, t (903) = .66, *OR* = 1.31, *95%CI*: [.59, 2.91], p = .511), nor was more homework days (b = .52, t(903) = 1.50, *OR* = 1.68, *95%CI*: [.85, 3.33], p = .135).

Is either measure of homework engagement related to response over and above the other?: In exploratory analyses, we included both measures of homework and all their interactions with treatment group and time in the GLMM model for response to treatment. These exploratory analyses showed that, for participants in CBT, homework compliance was significantly related to response over and above homework days (b = .93, t(903) = 2.09, *OR* = 2.52, *95%CI*: [1.06, 6.02], p = .037), but not vice versa (b = −.08, p = .927). And in KY, neither homework compliance (b = .70, p = .237) nor homework days (b = −.23, p = 7.17) were related to response over and above the other. It should be noted that our two measures of homework were highly correlated (r = .76, p < .001, as reported above). This multicollinearity can lead to unreliable results because it causes inflation of the variance of the regression coefficients, which can result in issues such as 1) very large regression coefficients, 2) Type II error due to large variances, or even 3) coefficients that are in the opposite direction of what is expected. Thus, these results may benefit from replication.

Discussion

This secondary analysis of a 12-week RCT comparing group CBT, KY, and SE for adults with GAD investigated average staff-rated homework compliance and average self-reported days per week of homework engagement as predictors of treatment response and as moderators of differences in treatment response between treatment groups. Our results extend findings that homework compliance is positively related to treatment response in CBT and provide novel contributions regarding the relationship between homework engagement and treatment response in yoga interventions for anxiety, a growing field of interest.

Our recent RCT found higher treatment response rates in CBT and KY compared to SE; however, KY failed to meet non-inferiority criteria when compared to CBT. Accordingly, in this present secondary analysis, participants assigned to CBT and KY were found to be more engaged in homework compared to those assigned to SE, and their homework engagement tended to relate more positively to response. This may be due to the active skills-based homework assigned in CBT and KY compared to the passive audiotapes prescribed in SE. More specifically, when examining the impact of homework engagement on response, we found that homework compliance scores were significantly related to CBT and KY response

(although in KY this relation was marginally significant, $p = .049$), whereas homework days per week was positively but not significantly related to CBT and KY response (although in CBT this relation was marginally significant, $p = .054$). Further, homework compliance was related to response over and above homework days in CBT, indicating that it explains a significant portion of the variability in response over and above the variance it shares with homework days (but not vice versa).

These findings align with prior literature establishing that homework engagement is associated with treatment outcome in CBT (Conklin et al., 2021; Mausbach et al., 2010). They also extend a previous meta-analysis that found that CBT studies utilizing staff-rated homework compliance scores found significantly higher mean effect sizes of homework compliance on response compared to studies using a percentage of homework assignments completed (Mausbach et al., 2010). Mausbach and colleagues suggest this may be because homework compliance scores can be inadvertently influenced by important CBT homework quality factors, whereas the percentage of homework assignments completed cannot (Mausbach et al., 2010). Homework quality may be particularly predictive of response in CBT. For example, a meta-analysis of homework effects in CBT found that homework quality measures predicted improvement at follow-up more strongly than homework quantity measures (Kazantzis et al., 2016). Individual studies of CBT for panic disorder, obsessive-compulsive disorder, and mixed anxiety disorders have found that homework measures focused on engagement with therapy skills relate to improvement more robustly or more durably than measures of homework completion (Anand et al., 2011; Conklin et al., 2021; Schmidt & Woolaway-Bickel, 2000). Our homework compliance scale, like the measure studied in the meta-analysis by Mausbach and colleagues (2010), focused on assignment *completion*. Nonetheless, because it included interviews with participants regarding their homework and a review of CBT worksheets, it is possible that homework quality factors became evident and influenced homework compliance scores, strengthening their relationship to CBT response.

Alternatively, homework compliance may have related to response over and above days per week in CBT because engagement with complex CBT homework tasks may be more precisely measured on a scale than by a frequency. Homework days per week could have overestimated homework engagement in participants who engaged in CBT for very few minutes spread out over many days, for example. Finally, our differential findings for our two measures may be related to their source (staff-rated vs. participant-reported). While a study of CBT for depression found that staff-rated, but not participant-reported, homework compliance measures predicted response (Schmidt & Woolaway-Bickel, 2000), subsequent meta-analyses have not found a clear trend between the source of homework data and its association with treatment response (Kazantzis et al., 2016; Mausbach et al., 2010). Thus, the role of the source in explaining our different findings for each homework measure is uncertain. Ultimately, more research is needed to understand why certain homework engagement measures predict CBT response more consistently than others.

Our KY findings suggest a positive relationship between yoga homework engagement and response, though not all findings reached the level of statistical significance. They differ slightly from previous literature, which has reported positive significant associations

between yoga sessions per week and treatment response (Hofmann et al., 2016), and quantity of home practice and treatment response in mindfulness-based interventions (Parsons et al., 2017). One possible explanation is the lower amount of homework prescribed (20 minutes per day) in our study. With participants averaging 2.9/6 days per week of yoga homework completion, the overall quantity of yoga homework completion was substantially lower than the average quantity of homework completed (180 minutes per week) reported by Parsons et al. (2017) in their meta-analysis associating mindfulness-based intervention homework with response. The duration of homework prescribed in our study may have been insufficient to facilitate optimal yoga homework benefit.

It is notable that our KY findings are less consistent compared to our CBT findings, and that the relationship between homework and outcome was not significantly greater in KY vs. SE as it was in CBT vs. SE, but also not significantly greater in CBT vs. KY. Another notable difference is the finding that neither homework engagement measure was superior to the other in KY. Because completing a timed and guided yoga sequence is fundamentally different from completing CBT tasks, more research may be needed to develop optimized homework engagement measures that account for quantity, quality, and perceived difficulty factors (Kazantzis & Miller, 2022) within a yoga context. Such tailored homework engagement measures may clarify yoga homework effects.

Our exploratory analyses highlight a relationship between homework effects and treatment session attendance that adds nuance to understanding the relationship between homework and session engagement. Prior CBT studies have associated homework engagement with high session attendance (Conklin et al., 2021) and high session attendance with improved outcomes (Glenn et al., 2013), suggesting that homework engagement and session engagement work together to facilitate response. Our finding that higher session attendance reduced the effect of homework compliance on response in CBT, and that the highest session attenders across treatments did not receive added benefit from homework engagement, suggests that homework engagement was most valuable for study participants who missed sessions. This may be especially applicable to group treatment, in which it is more difficult for the therapist to flexibly adjust sessions to ensure content missed by one participant is covered in a future session. As such, group therapists can pay special attention to homework engagement to “catch up” participants who remain engaged but periodically miss sessions.

Limitations in the study design, sample, and methods should be noted. First, to be able to examine homework data for included participants, our sample size was limited to those who completed at least two intervention sessions and one homework log (n = 190 from n = 226 randomized). This 190 person sample was disproportionately educated (46.3% graduated college and did not attend graduate school; 38.4% with some or completed graduate school) and may have engaged more with homework than do average clinical populations. Second, prior research has shown that different homework compliance measures, as well as the sourcing and timing of their collection may differentially relate to treatment response (Kazantzis et al., 2016; Mausbach et al., 2010; Schmidt & Woolaway-Bickel, 2000). While this study’s use of two different measures of homework, one staff-rated and one self-report, taken at frequent time points is a strength, the absence of measures explicitly focused on homework quality is a limitation. Homework quality may have a stronger

and more durable effect on treatment outcome than homework completion (Anand et al., 2011; Conklin et al., 2021; Kazantzis et al., 2016; Neimeyer & Feixas, 1990; Schmidt & Woolaway-Bickel, 2000), and future studies should incorporate explicit measures of CBT and yoga homework quality. Third, use of a continuous outcome variable could have allowed for the detection of more subtle relationships between homework engagement and symptom change. Nonetheless, the strength of a binary responder/non-responder outcome variable is its translation to real-world clinical outcomes (treatment response) and alignment with the primary endpoint used in the main outcomes paper (Simon et al., 2021). Fourth, the manualized nature of homework assignments, while common to group psychotherapies, is a distinct approach from the collaborative, individualized determination of inter-session tasks that occurs in individual therapy (Kazantzis & Miller, 2022). Standardized tasks may miss some of the mechanistic factors that exist in individually tailored assignments (Kazantzis & Miller, 2022). Finally, in these secondary analyses there was no adjustment for multiple testing. Strengths of this secondary analysis include incorporation of rigorous primary RCT data pertaining to a popular but understudied application of yoga for anxiety, use of a modified intention to treat model in the examination of the effect of homework engagement on treatment response, and attention to the role of session attendance in the relationship between homework engagement and treatment response.

This study expands upon the homework–outcome relationship literature across psychotherapies for anxiety. It reinforces the importance of CBT homework in optimizing CBT efficacy and nuances our understanding of the relationship between session engagement and homework engagement, finding that participants who missed sessions gained the most from strong homework engagement. It is the first to our knowledge to report on the impact of yoga homework engagement on response within a rigorous RCT. While the results hint at positive but possibly weaker yoga homework effects, future studies are needed to clarify the impact of homework engagement on clinical outcome in yoga treatments for GAD. Future research would benefit from considering the duration of prescribed yoga homework and the development of homework measures designed to comprehensively assess yoga homework engagement.

Funding

This work was supported by a collaborative R01 to Drs. Simon and Hofmann from the National Center for Complementary and Integrative Health [NCCIH: 1R01AT007258; 1R01AT007257]. Dr. Szuhany's time was supported by the National Institute of Mental Health [NIMH: K23MH122773] and by a NARSAD Young Investigator Grant from the Brain & Behavior Research Foundation. The sponsor (NCCIH) gave feedback on the design and conduct of the study prior to study initiation. The sponsor or other funding sources did not have any role in the collection, analysis, and interpretation of data; in the writing of the report; and in the decision to submit the article for publication.

Disclosure statement

Dr. Baker receives royalties from New Harbinger Publications.

Dr. Khalsa reported receiving grants from the NCCIH, NIH during the conduct of the study; receiving grants from Kundalini Research Institute, from International Association of Yoga Therapists and Kripalu Center for Yoga & Health outside the submitted work; and being a practitioner and certified instructor in Kundalini yoga as taught by Yogi Bhajan.

Dr. Bui reported receiving grants from the NIH during the conduct of the study and receiving royalties from Springer and from Wolters Kluwyer, and grants from the US Department of Defense, Osher Center for Integrative Medicine, Patient-Centered Outcomes Research Institute, and Elizabeth Dole Foundation outside the submitted work.

Dr. Hoeppner 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 the National Institute on Drug Abuse outside the submitted work.

Dr. Rosenfield reported receiving grants and personal fees from the NCCIH, NIH, and NIDA during the conduct of the study. He also receives compensation for his editorial work for JAMA Psychiatry and Behaviour Research and Therapy, and consulting fees from Rosenfield Analytics, LLC.

Dr. Hofmann receives financial support by the Alexander von Humboldt Foundation (as part of the Alexander von Humboldt Professur), the Hessische Ministerium für Wissenschaft und Kunst (as part of the LOEWE Spitzenprofessur), the DYNAMIC center, funded by the LOEWE program of the Hessian Ministry of Science and Arts (Grant Number: LOEWE1/16/519/03/09.001(0009)/98), the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation)—Project-ID 521,379,614 – TRR 393SFB/Transregio 393 and the Excellence Cluster E × C3066 “The Adaptive Mind.” He also receives compensation for his work as editor from SpringerNature and royalties and payments for his work from various publishers.

In the past 3 years, Dr. Simon reports receiving grants from the National Institutes of Health (NIH), American Foundation for Suicide Prevention, Patient-Centered Outcomes Research Institute, Ananda Scientific and support from Cohen Veterans Network and MindMed; receiving personal fees from Genomind, Cerevel; receiving fees or royalties from Wiley (Deputy Editor Depression and Anxiety), Wolters Kluwyer (UpToDate) and APA Publishing (Textbook of Anxiety, Trauma and OCD Related Disorders 2020); and having spousal stock from G1 Therapeutics and Zentalis outside the submitted work.

All other authors report no conflicts of interest.

Data availability statement

De-identified data from this research study are not available in a public archive. De-identified data from this research study will be made available (as allowable according to IRB standards) by emailing the corresponding author.

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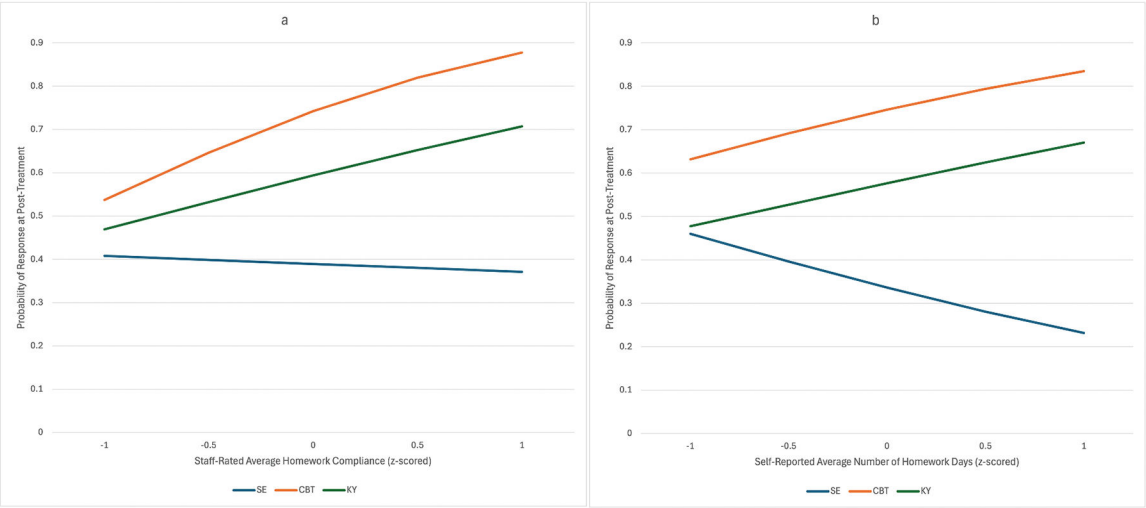

Figure 1.

Relationship between homework engagement and treatment response in each treatment group. a. Staff-rated homework compliance was positively associated with treatment response in group cognitive behavioral therapy (CBT) and Kundalini yoga (KY), but not in stress education (SE). b. A similar relationship was found for self-reported average number of homework days.

Table 1.

Baseline sample characteristics.

Variable	CBT (*N* = 79)	KY (*N* = 76)	SE (*N* = 35)	Total (*N* = 190)
Age, mean (SD)	34.6 (13.2)	32.4 (12.8)	31.5 (13.7)	33.2 (13.1)
Female, n (%)	55 (70)	55 (72.4)	24 (68.6)	134 (70.5)
Race, n (%)				
White	59 (74.7)	65 (85.5)	24 (68.5)	148 (77.9)
Black	5 (6.3)	2 (2.6)	3 (8.6)	10 (5.3)
Asian/Pacific Islander	7 (8.9)	7 (9.2)	5 (14.3)	19 (10)
Other/Multiracial	8 (10)	2 (2.6)	3 (8.6)	13 (6.8)
Ethnicity, n (%)				
Hispanic/Latino	11 (13.9)	12 (15.8)	2 (5.7)	25 (13.2)
Not Hispanic/Latino	68 (86.1)	64 (84.2)	33 (94.3)	165 (86.8)
Educational level, n (%)				
High school or less	1 (1.3)	1 (1.3)	3 (8.6)	5 (2.6)
Technical school or some college	9 (11.4)	9 (11.8)	4 (11.4)	22 (11.6)
College graduate	40 (50.6)	33 (43.4)	15 (42.9)	88 (46.3)
Graduate or professional school (some or completed)	29 (36.7)	32 (42.1)	12 (34.3)	73 (38.4)
Current Comorbid MDD, n (%)	20 (25.3) *	6 (8) *	7 (20)	33 (17.4)

Note.

* $p < .01$;

CBT = cognitive behavioral therapy; KY = kundalini yoga; SE = stress education; MDD = major depressive disorder.

Table 2.

Effect of homework engagement on response.

	Homework compliance			Homework days		
Variable	**Coefficient**	**OR(95% CI)**	**p**	**Coefficient**	**OR (95% CI)**	**p**
Time	0.30	1.36 (1.28–1.44)	<.001***	0.30	1.35(1.27–1.43)	<.001***
CBT (vs SE)	0.74	2.09 (1.28–3.43)	.003**	0.87	2.37(1.39–4.04)	.002**
KY (vs SE)	0.41	1.50(0.91–2.49)	.113	0.49	1.63(0.94–2.80)	.080
Time ×CBT	0.07	1.07(1.00–1.16)	.111	0.08	0.92(0.64–1.3)	.600
Time ×KY	0.02	1.02(0.94–1.11)	.671	0.02	1.02(0.93–1.12)	.628
HW	0.56	1.74 (1.23–2.48)	.002**	0.28	1.33(0.94–1.87)	.108
HW × Time	0.06	1.06(0.99–1.12)	.082	0.04	1.04(0.98–1.11)	.180
HW × CBT	0.48	1.62 (1.06–2.49)	.027*	0.52	2.18 (1.02–4.64)	.045*
HW × KY	0.29	1.33(0.91–2.49)	.145	0.45	1.97(0.95–4.10)	.069
HW × CBT × Time	0.06	1.06(0.98–1.15)	.147	0.06	1.09(0.95–1.26)	.211
HW × KY × Time	0.01	1.01(0.94–1.08)	.769	0.03	1.05(0.92–1.20)	.498
Session Attendance	−0.06	0.95(0.71–1.26)	0.71	−0.04	0.99(0.89–1.09)	0.78

Note:

* $p < .05$,

** $p < .01$,

*** $p < .001$;

OR = odds ratio; CBT = cognitive behavioral therapy versus stress education; KY = kundalini yoga versus stress education; HW = homework; Homework days = self-reported days per week engaged in homework; Homework compliance = staff-rated homework compliance; The two homework engagement variables were z-scored to allow rough comparisons between their effects. The dummy coded treatment condition variables were also z-scored in these analyses so that sub-components of interactions involving these variables (e.g. the main effects of homework and the homework × Time interactions) would reflect these effects for the average participant across all groups. Hence, these effects do not reflect their effects in any of the specific treatment groups. The effects of homework within each separate treatment group are derived from this same model, but with treatment groups recoded (using simple slopes analysis) to yield specific effects for specific treatment groups.