

Mindfulness Meditation Apps: An Effective Tool to Improve Mental Health Among Graduate Students in STEM Programs

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Mindfulness Meditation Apps: An Effective Tool to Improve Mental Health among Graduate
Students in STEM Programs

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Abstract:

This paper seeks to determine whether or not mindfulness meditation training via a simple meditation app can effectively improve well-being among graduate students enrolled in STEM programs. Graduate students were recruited from STEM programs at the University of Florida. Participants were randomly assigned into treatment and control groups. The control group simply proceeded as they normally would during an academic semester. The treatment group received free access to the Ten Percent Happier app and were asked to meditate once per day for eight weeks. Both groups completed pre-, mid-, and post-intervention surveys that included the Center for Epidemiological Depression Scale (CES-D) and the Generalized Anxiety Disorder 7-Item Scale (GAD-7). The treatment group averaged about 10 minutes of meditation per day, and the average participant meditated on about 82% of days within the intervention period. At the end of the 8-week intervention, the treatment group reported CES-D and GAD-7 scores that were about 35% and 41% lower than the control group and their physical symptom score was about 36% lower. Relative to their own starting scores, CES-D, GAD-7, and physical symptom scores decreased 35%, 50%, and 43%, respectively for the treatment group, while the control group experienced no change in scores.

Introduction

A recent survey of graduate students across 26 countries indicated startling rates of depression and anxiety among graduate students. Forty-one percent suffered from moderate to severe anxiety while 39% suffered from moderate to severe depression (Evans et al. 2018). Focusing specifically on PhD students in the U.S., Canada, China, Australia, and Belgium, a recent meta-analysis found rates of anxiety ranging from 8% to 49% and rates of depression ranging from 7% to 50% (Satinsky et al. 2021). Pre-pandemic, rates for these mental illnesses were both approximately 6% in the general population (Evans et al. 2018). Given these high rates, it is imperative that changes are made to our graduate programs to ensure better mental health and that current graduate students are given tools to improve their mental health.

A review of studies on the impact of mindfulness meditation on mental health, across a broad demographic range of participants, indicated that in about half of studies, meditation interventions were associated with improvements in mental health (Tonneatto and Nguyen 2007). In contrast, a review of studies focusing only on meditation interventions among undergraduate students found that in most studies, mindfulness meditation was associated with a decrease in anxiety and that this impact was often a substantial reduction (Bamber and Morpeth 2019). In a review of meditation use across the U.S., combatting anxiety, stress, and depression were the most commonly cited health reasons for the respondents' meditation practices, with 29.2%, 21.6%, and 17.8% of respondents listing these reasons (Cramer 2016). These findings suggest that mindfulness meditation might be a useful tool for graduate students as well.

However, the literature on meditation interventions among graduate students is more limited than interventions among undergraduate students. Most previous work on graduate students has considered interventions applied to health-related graduate or professional programs

such as counseling, psychology, medical, and nursing programs (Kong 2008, Schure et al. 2008, Shapiro et al. 1996, Short et al. 2015, Spadaro and Hunker 2016). These kinds of students may be more likely to be receptive to meditation or to have had formal coursework that advocates for tools like meditation. Much of the previous literature relies on courses for which students must formally enroll for course credit (Schure et al. 2008, Spadaro and Hunker 2016, Tarrash 2015) or other structured synchronous courses (Chu 2009, Shapiro et al. 1996, Short et al. 2015) instead of an intervention that the students can pursue on their own schedule.

While two studies utilized a treatment and control method, one consisted of only 10 students in the treatment group and 9 students in the control (Chu 2009). The second relied on 7 30-minute training sessions per week in addition to daily journal assignments and weekly home practice assignments (Shapiro et al. 1996). While this likely provided strong training in meditation, commitment to this kind of an intervention is likely unrealistic for most graduate students. The remainder of the studies rely only on pre- and post-intervention measures of the treated group (Kong, 2008, Schure et al. 2008, Short et al. 2015, Spadaro and Hunker 2016, Tarrash 2015). This paper adds to the existing literature by considering graduate students across a broad range of STEM disciplines, by utilizing a treatment and control method approach, and by testing an intervention that has strong potential for use among graduate students by nature of its ease and flexibility.

Methods

After receiving approval from the Institutional Review Board (IRB) at the University of Florida, in fall 2020, graduate students from STEM disciplines were recruited from departments within the College of Agricultural and Life Sciences, College of Letters, Arts, and Sciences, and the College of Engineering at the University of Florida. Graduate Coordinators from each department were

emailed and asked to distribute a recruitment email to their graduate students. Thirty-seven departments in total were contacted; 21 agreed to distribute the recruitment emails. The remaining graduate coordinators did not respond to the request, so reasons for not participating are unknown. The email explained that the program was recruiting students for an 8-week meditation study. All participants would receive 4-months of access to the Ten Percent Happier App, normally only available through a paid subscription, but half of the group would receive the app at the start of the study period and the remaining half, the randomly selected control group, would receive the app at the conclusion of the study period.

To enroll in the study, students were asked to complete a short survey, collecting their department, program, and location information as well as collecting their informed consent to participate in the study. During the week of October 4, all participants were provided with the pre-intervention survey. This survey collected information about their previous meditation experience, the amount of time they currently spend on work/life balance activities like sleep, exercise, hobbies, and socializing, and basic demographic information. The survey also included three measures of well-being.

The first measure was the Center for Epidemiologic Studies Depression Scale (CES-D) (Radloff 1977) which includes 20 statements such as “I was bothered by things that usually don’t bother me” and “I felt lonely.” Table S1 in the supplementary materials contains the complete list of statements. In the traditional scale, respondents are asked to respond with: rarely or none of the time (less than 1 day), some or a little of the time (1 – 2 days), occasionally or a moderate amount of the time (3 – 4 days), or most or all of the time (5 – 7 days), and these responses are given scores ranging from 0 to 3, respectively. Respondents scoring 16 or higher are generally diagnosed with depression, but cut-off points vary across studies (Vilagut et al. 2016).

The second measure is the Generalized Anxiety Disorder 7-item (GAD-7) Scale (Spitzer et al. 2006) which contains 7 statements such as “Feeling nervous, anxious, or on edge” and “Being so restless that it is hard to sit still.” The entire list of statements is included in Table S1 in the supplementary materials. In the traditional scale, respondents are asked to respond with: not at all, several days, more than half the days, and nearly every day, and these responses are given scores ranging from 0 to 3, respectively. Respondents are then categorized as having mild, moderate, or severe anxiety if they receive scores of 5, 10, or 15 or more, respectively.

Lastly, the third measure considered physical ailments that might accompany stress and anxiety. These were taken from question 3 of the Anxiety Disorder Diagnostic Questionnaire (ADDQ) (Norton and Robinson 2012). In the original questionnaire, patients would be asked to check all physical symptoms which they experience frequently.

For each measure, respondents were asked to consider their experiences in the preceding calendar week. Given the discrepancies between frequencies used in the CES-D (smooth 2 – 3 day increments) and GAD-7 (increments that include extreme end ranges of not at all and nearly every day), the survey used the following categories across all three measures: not at all (experienced on 0 days), some of the time (experienced on 1 – 2 days), a moderate amount of time (experienced 3 – 4 days), most of the time (experienced on 5 – 6 days), and all of the time (experienced on 7 days), and these responses were given scores of 0 to 4, respectively. Given that maximum scores were scaled by 33%, in the analysis that follows the cutoffs were correspondingly scaled up by 33%. This resulted in a cutoff for depression of 21 instead of 16 and the cutoffs for mild, moderate, and severe anxiety set to 7, 13, and 20, respectively. No cutoff existed for the physical symptoms index so this measure is only presented as a raw score.

Following completion of the pre-intervention survey, participants were randomly assigned

to the treatment (45 participants) or control (44 participants) group. On Monday, October 12, the treatment group received access to the Ten Percent Happier (TPH) App and instructions for the study. They were asked to meditate once per day and were encouraged to use the app's reminder feature to assist with establishing the daily habit. In addition to single meditation sessions, TPH includes multi-day courses on meditation. Each course is centered around a theme, and each session within the course includes a short video with explanations of concepts and then a longer guided meditation session. Respondents were asked to work through Basics I (7 days, 5 – 10 minutes/day) and Basics II (8 days, 14 – 17 minutes/day) first. After completing these two courses, they were allowed to choose from the following courses:

1. Essential Advice (14 days, 15 – 19 minutes/day)
2. Common Questions (24 days, 17 – 22 minutes/day)
3. Relationships (15 days, 15 – 20 minutes/day)
4. Stress Better (7 days, 12 – 14 minutes/day)
5. Emotions (15 days, 13 – 16 minutes/day)
6. Focus (14 days, 16 – 20 minutes/day)
7. Performance (12 days, 16 – 21 minutes/day).

Course options were chosen based on topics that might be most relevant to them as well as to ensure that participants had a diverse set of instructors from whom to learn. This same week, the control group received an email informing them that they had been assigned to the control group. They were instructed to continue on with their semester as they normally would.

On November 8, 2020, participants in both the treatment and control groups received an email asking them to complete the midpoint survey by Nov. 14 at midnight. For all participants, this survey repeated the CES-D, GAD-7, and physical symptoms questions, asking participants to

respond based on how they felt during the week of Nov. 1 – 7. It should be noted that the 2020 presidential election took place during this time period, which may have added noise to the responses. Participants in the treatment group were asked to report usage stats for the first 4 weeks of the study provided by the app including: number of mindful days (days with at least one meditation session), total number of sessions, total number of minutes of meditation practice, and their current streak in terms of days with a meditation practice. They were also shown the list of courses they could have worked on and were asked to indicate which they had completed and which they had started but not completed. Participants received reminder emails on Nov. 11 and 13 if they had not completed the survey.

On Dec. 6, participants in both treatment and control groups received an email asking them to complete the final survey by Dec. 12. Again, participants in both groups responded to the CES-D, GAD-7, and physical symptoms questions, and participants in the treatment group were asked to report their meditation statistics and courses taken. Participants received reminder emails on Dec. 9 and Dec. 11 if they had not completed the survey. The control group received access to the app after completing the final survey. For the duration of the study, all methods were performed in accordance with IRB guidelines.

Data

89 graduate students enrolled in the study. Table 1 includes basic demographic information about the sample. The majority of the students were female, enrolled in a program in the College of Agricultural and Life Sciences, PhD students, white, and located on the main campus in Gainesville, FL as opposed to off-campus at a Research and Education Center. There were no significant differences in basic demographic information between the treatment and control

groups. In terms of well-being measures, the treatment group has slightly higher rates of mild and severe anxiety, depression, and physical symptoms. However, these differences were not statistically significant.

At the midpoint survey, 37 and 35 participants from the control and treatment groups, respectively, responded. At the final survey, 35 and 33 participants from the control and treatment groups, respectively, responded. This attrition has potential ramifications for applicability of results and will be discussed more thoroughly below.

Results

Table 2 presents basic analysis of factors correlated with each of the three measures of well-being prior to the intervention. Not surprisingly, there are correlations between CES-D and GAD-7 scores and between physical symptoms of stress and anxiety and GAD-7 scores. Interestingly, most measures of work/life balance are not associated with any of the well-being measures except for leisure which is negatively correlated with GAD-7 scores. In terms of demographics, male students had GAD-7 scores that were about 1.6 points lower than female students, white students had CES-D scores that were about 5.4 points lower than non-white students, and PhD students had GAD-7 scores that were about 2.6 points lower than MS students.

Table 3 shows the number of participants completing each survey for the treatment and control groups. Between the pre-intervention survey and the midpoint survey, about 16% of the control group dropped out and 22% of the treatment group. However, from the midpoint survey to the post-intervention survey, only about 5% and 6% of the control and treatment groups dropped out, respectively. The analysis of the impact of the intervention that follows will only include those who remained in the study for the entire duration of the study. Analysis of factors associated with

attrition will also be discussed further below.

Table 4 reports the meditation activity of the treatment group. During the first four weeks of the study, participants meditated for an average of 281 minutes or approximately 10 minutes per day. They averaged about 26 sessions, equivalent to meditating on 93% of days, with an average current streak of about 5 days at the time of taking the survey. Not surprisingly, intensity of participation decreased in the second half of the study, bringing the total average minutes down to about 9.5 per day with sessions occurring on about 82% of days. However, the average streak was slightly higher, averaging about 6.6 days at the end of the study.

The top half of Table 5 includes tests for differences in CES-D, GAD-7, and physical symptoms between the control and treatment groups from the pre-intervention, mid-intervention, and post-intervention surveys, as well as a test for differences-in-differences between pre- and post-intervention. For all three measures, there are no statistically significant differences in scores between the treatment and control groups in the pre-intervention week. In week 4, the treatment group had statistically significantly lower CES-D scores on average, relative to the control group. However, no significant differences were seen between groups for GAD-7 or physical scores. By week 8, the treatment group's scores were statistically significantly lower than the control group for all three measures, and the difference-in-differences measure is also statistically significantly different from zero. The magnitudes of the reductions are also substantial. The treatment group reported CES-D and GAD-7 scores that were about 35% and 41% lower than the control group and their physical symptom score was about 36% lower. Recalling that the treatment group started the intervention with slightly higher scores than the control group, a comparison with their own starting scores yields reductions in CES-D, GAD-7, and physical symptom scores of 35%, 50%, and 43%, respectively. These are potentially meaningful changes in well-being. In previous

literature, Shapiro et al. (1996) found approximately 6 to 14% reductions in their measures of anxiety and an approximately 32% reduction in their measure of depression for an 8-week mindfulness-based stress reduction program (yoga, meditation, mindful eating, etc.) among pre-medical and medical students. The treatment consisted of 7 30-minute sessions each week, weekly home practice assignments, and daily journaling. Interestingly, the impacts found using the TPH app are larger than those found with a more time-intensive intervention. Spadaro and Hunker (2016) found no significant changes in depression scores after their 8-week intervention but did find a 27.7% reduction in their anxiety measure at the end of the intervention. In their study, students received training on one type of mindfulness-based stress reduction (yoga, meditation, mindful eating, etc.) each week and were asked to practice that training each day for the remainder of the week.

The lower half of Table 5 includes differences in the rate of GAD-7 scores that meet the criteria for at least mild, at least moderate, and severe anxiety, and CES-D scores that meet the criterion for depression. As before, no differences were observed between rates in the treatment and control group in the pre-intervention week. In week 4, differences in groups only existed for the rate of mild anxiety. By week 8, the treatment group had lower rates of at least mild and at least moderate anxiety. Interestingly, there are no differences between treatment and control in terms of rate of depression in either the pre-intervention period or week 8, but the difference-in-differences measure suggests that the treatment group had a different trajectory in its rate of depression relative to the control group, which had the same rates in pre- and post-surveys, while the treatment group reduced its rate by 20 percentage points over the same timeframe.

Using tobit regression models, the CES-D, GAD-7, and physical symptoms scores were estimated as a function of treatment group status, time period, and the interaction of treatment

group status and time period. Table S2 in the supplementary materials contains regression output as well as the same tobit models estimated while controlling for demographic characteristics of participants. Figure 1 plots the predicted scores over time for treatment vs. control with 95% confidence intervals. For all three scores, there is a steady decline across time for the treatment group but not for the control. For CES-D scores, the difference in predicted scores for treatment vs. control is statistically significantly different from zero. For the other two scores, overlap exists between the confidence intervals, suggesting that while on average, meditation resulted in lower scores, the variation in impact of treatment is large enough that for some individuals, there will be no impact.

Using logit regression models, the predicted probabilities of meeting the criteria for depression, at least mild anxiety, at least moderate anxiety, and severe anxiety were estimated as a function of treatment group status, time period, and the interaction of treatment group status and time period. Table S3 in the supplementary materials contains regression output as well as the same logit models estimated while controlling for demographic characteristics of participants. Figure 2 plots the predicted probabilities over time for treatment vs. control with 95% confidence intervals. With the exception of severe anxiety, the treatment group shows a steady decline across time, while the control group does not. There is a large gap between confidence intervals for predicted probability of at least mild anxiety between treatment and control by week 8. For depression and at least moderate anxiety, there is some overlap in confidence intervals. For severe anxiety, there appears to be little impact of meditation.

For all measures for which meditation was impactful, an increase in effectiveness can be observed between the midpoint and post-intervention measures. Given the decrease in average duration and/or frequency of meditation in the second half of the study, it appears that cumulative

meditation practice is more impactful than current frequency of practice. This suggests that establishing a regular meditation practice, even if one fails to establish a daily practice, could be beneficial for graduate students.

Attrition

As shown in Table 3, the study suffered from some attrition in both the treatment and control groups. Interestingly, the largest drop-off occurred in the first four weeks; most who made it to week 4 continued in the study until week 8. To fully assess the efficacy of meditation interventions on graduate student well-being, it is imperative that the analysis considers who opted out of the intervention. Table 6 reports the output of logit models of attrition, considering the pre-intervention levels of the well-being scales themselves and categories of well-being, as determined by diagnostic cutoffs for depression, mild anxiety, moderate anxiety, and severe anxiety. As can be seen in Table 6, overall, attrition was not higher for the treat group relative to the control group. However, higher CES-D scores were associated with higher attrition for the mid-intervention survey for those in the treatment group, and those categorized as potentially having at least mild anxiety or severe anxiety were more likely to drop out of the treatment group by the post-intervention survey. As a reminder, the preceding analysis only makes use of those who remained in the survey for the duration of the study, so the impacts observed are not just stemming from those with worse well-being at the start of the intervention dropping out of the study. However, these patterns of attrition suggest that, while meditation may be an effective intervention for some graduate students, others suffering from depression and/or anxiety may not continue with such a program. Ways to keep these individuals in the intervention, such as increased incentives for participation, a buddy system for accountability, or perhaps a group class could be explored. Conversely, for those in the treatment group, meditation might have been so ineffective and/or

difficult or uncomfortable that remaining in the study would not have improved their well-being. Future research should explore these implications.

Limitations

Ideally, this study would have identified a minimum treatment threshold above which one can experience improvements in mental health. Unfortunately, the data demonstrate that those participants who had better mental health pre-intervention were more likely to meditate more regularly during the intervention period. Without variables that can predict meditation time that do not also predict well-being, we cannot determine how total time spent meditating impacts mental health. Future iterations of this study should assign students to different levels of treatment to better distinguish the impact of treatment intensity.

Conclusions and Discussion

This research has demonstrated that a low-cost intervention with a small per-day time commitment can have tangible impacts on graduate student well-being. Unlike much of the previous literature, this intervention does not rely on formal in-person courses or lengthy time commitments. The intervention can be done on the student's own time and schedule. The results also demonstrate that impacts increase over time even if one's meditation practice becomes less consistent over time. This has important implications for graduate students whose available time may fluctuate across a semester and who might be more likely to be people for which efforts tend to be "all or nothing" in nature. Simply maintaining a meditation practice as often as possible can yield benefits.

As previously discussed in the results section, the impacts of this intervention were equal to or greater than the impacts found in the literature from more time-consuming mindfulness training interventions. However, graduate students potentially have a wider range of tools available

to them. Ratanasiripong et al. (2015) explored the impact of the use of a biofeedback intervention, where participants were trained to use a portable heart rate variability (HRV) monitor. While using the monitor, they were asked to breathe slowly and feel positive emotions until they sustained an HRV associated with positive emotions. They were then asked to use the device three times a day for four weeks. The treatment groups experienced a 25% reduction in anxiety scores and a 13% reduction in depression scores relative to the control group and 28% and 18% reductions, respectively, relative to their original scores. This intervention is similar in nature to the TPH intervention in that participants could use the device on their own schedule and entailed a relatively small time commitment. Their reductions after four weeks were also very similar to those found at the midpoint of the 8-week TPH intervention, suggesting that this intervention could be a potential substitute for those who had difficulty continuing with the meditation intervention. Receiving real-time feedback would likely be helpful in mitigating attrition. Indeed, it appears that the biofeedback intervention did not have any attrition.

Another intervention tested the efficacy of forest walking. In this intervention, participants walked together in a forest for about 1 hour each week for 6 weeks and were encouraged to walk at least once more on their own each week. This intervention achieved a 21% reduction in the treatment group's depression scores relative to the control and 26% decrease relative to the treatment group's pre-intervention scores. Given the relatively small time commitment incurred from this intervention, for those graduate students with access to trails, this could be a highly appealing intervention.

Given the relatively high rates of CES-D and GAD-7 scores associated with potential depression and anxiety among the study's participants, it is clear that mental health deserves more attention among our graduate programs. The attrition found in this study, as well as written

comments on the surveys about struggles specific students had with meditation (difficulty sitting still for an entire meditation, feeling more anxious when focusing on their breath, etc.) suggest that there is no one solution that will meet the needs of all students. Instead, graduate programs should offer or at least encourage the use of several different tools that have been shown to be helpful. Additionally, faculty within graduate programs should be cognizant of how they are modeling work-life balance and what kinds of demands they are imposing, either intentionally or unintentionally, on their students that might be impeding the students' abilities to prioritize practices to improve their mental health.

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Table 1. Summary Statistics of Study Participants

	Control (N = 44)		Treatment (N = 45)	
	Mean	Std. Dev.	Mean	Std. Dev.
<i>Demographic Characteristics</i>				
Male	0.34	0.48	0.40	0.50
Age	27.57	4.41	28.53	6.39
College:				
Ag and Life Sciences	0.50	0.51	0.58	0.50
Letters, Arts, & Sciences	0.20	0.41	0.20	0.40
Engineering	0.18	0.39	0.20	0.40
PhD Student	0.75	0.44	0.82	0.39
REC Student	0.14	0.35	0.16	0.37
Race/Ethnicity:				
White	0.80	0.41	0.71	0.46
Black	0.02	0.15	0.02	0.15
Native American	0.00	0.00	0.00	0.00
Asian	0.07	0.25	0.16	0.37
Latino	0.18	0.39	0.16	0.37
Nat. Hawaiian/Pac. Islander	0.00	0.00	0.02	0.15
Other	0.02	0.15	0.00	0.00
<i>Well-being Measures</i>				
GAD-7	10.27	7.12	11.11	13.08
≥ Mild Anxiety	0.61	0.49	0.71	0.46
≥ Moderate Anxiety	0.34	0.48	0.33	0.48
≥ Severe Anxiety	0.11	0.32	0.13	0.34
CES-D	24.69	13.82	25.95	13.08
Depression	0.57	0.50	0.64	0.48
Physical Scale	16.95	11.14	19.33	12.13
Heartrate	70.26	11.76	72.93	15.91

*Note- sample means/proportions are not statistically significantly different between treatment and control group for any variable.

Table 2. Baseline CES-D, GAD-7, and Physical Scale Scores as a Function of Well-Being Scores, Time Spent in Activities, and Sociodemographic Characteristics

	CES-D Scale	GAD-7 Scale	Physical Scale
CES-D Scale		0.266*** (0.039)	0.064 (0.107)
GAD-7 Scale	1.399*** (0.222)		1.188*** (0.202)
Physical Scale	0.081 (0.135)	0.282*** (0.045)	
Time Spent in:			
Leisure	0.752* (0.384)	-0.277* (0.157)	0.180 (0.350)
Exercise	-0.366 (0.296)	0.120 (0.121)	0.014 (0.266)
Social Activities	-0.015 (0.415)	-0.034 (0.168)	-0.028 (0.369)
Male	2.728 (2.132)	-1.552* (0.857)	1.371 (1.910)
Age	-0.263 (0.216)	0.119 (0.088)	-0.029 (0.194)
White	-5.355** (2.447)	1.626 (1.008)	-0.676 (2.247)
COE	-0.608 (2.932)	0.970 (1.192)	-3.878 (2.564)
CLAS	0.115 (2.736)	0.485 (1.111)	-2.994 (2.405)
PhD	4.730 (3.042)	-2.557** (1.230)	1.608 (2.743)
Constant	12.251* (7.191)	-2.118 (2.990)	4.113 (6.505)
N	81	81	81
R-sq	0.649	0.219	0.642

Table 3. Attrition

	Control	Treatment
Pre-intervention	44	45
Mid-Intervention	37	35
Post-Intervention	35	33

Table 4. Meditation Activity of Treatment Group for First Four Weeks and Entire Intervention

	Mean	Standard Deviation	Min	Max	Per Day or % of Days
Minutes					
First 4 weeks	281.00	166.85	0	851	10.04
Total	533.36	324.37	0	1185	9.52
Sessions					
First 4 weeks	25.91	15.46	0	74	0.93
Total	46.15	25.85	0	106	0.82
Streak					
First 4 weeks	5.37	7.84	0	28	
Total	6.64	14.04	0	56	

Table 5. Comparison of CES-D, GAD-7, and Physical Symptom Scores

	Control (35)	Treatment (33)	Difference
<i>CES-D</i>			
Pre-Intervention	23.794	23.323	-0.472
Mid-Intervention	25.441	19.767	-5.674*
Post-Intervention	23.324	15.152	-8.172***
Diff-in-Diff			-7.700*
<i>GAD-7</i>			
Pre-Intervention	9.743	10.273	0.53
Mid-Intervention	9.971	7.533	-2.438
Post-Intervention	8.686	5.091	-3.595**
Diff-in-Diff			-4.125*
<i>Physical</i>			
Pre-Intervention	16.485	18.903	2.418
Mid-Intervention	14.588	15.6	1.012
Post-Intervention	17.029	10.867	-6.163**
Diff-in-Diff			-8.581**
<i>≥ Mild Anxiety</i>			
Pre-Intervention	0.600	0.667	0.067
Mid-Intervention	0.657	0.455	-0.203*
Post-Intervention	0.571	0.152	-0.420***
Diff-in-Diff			-0.487***
<i>≥ Moderate Anxiety</i>			
Pre-Intervention	0.286	0.303	0.017
Mid-Intervention	0.314	0.273	-0.042
Post-Intervention	0.229	0.061	-0.168*
Diff-in-Diff			-0.185
<i>≥ Severe Anxiety</i>			
Pre-Intervention	0.114	0.091	-0.023
Mid-Intervention	0.086	0.182	0.096
Post-Intervention	0.086	0.030	-0.055
Diff-in-Diff			-0.032
<i>Depression</i>			
Pre-Intervention	0.533	0.621	0.088
Mid-Intervention	0.571	0.394	-0.177
Post-Intervention	0.533	0.424	-0.109
Diff-in-Diff			-0.197**

Note: *, **, and *** indicate significance at the 0.1, 0.05, and 0.001 levels, respectively. Diff-in-Diff compares the difference-in-differences for pre- to post-intervention.

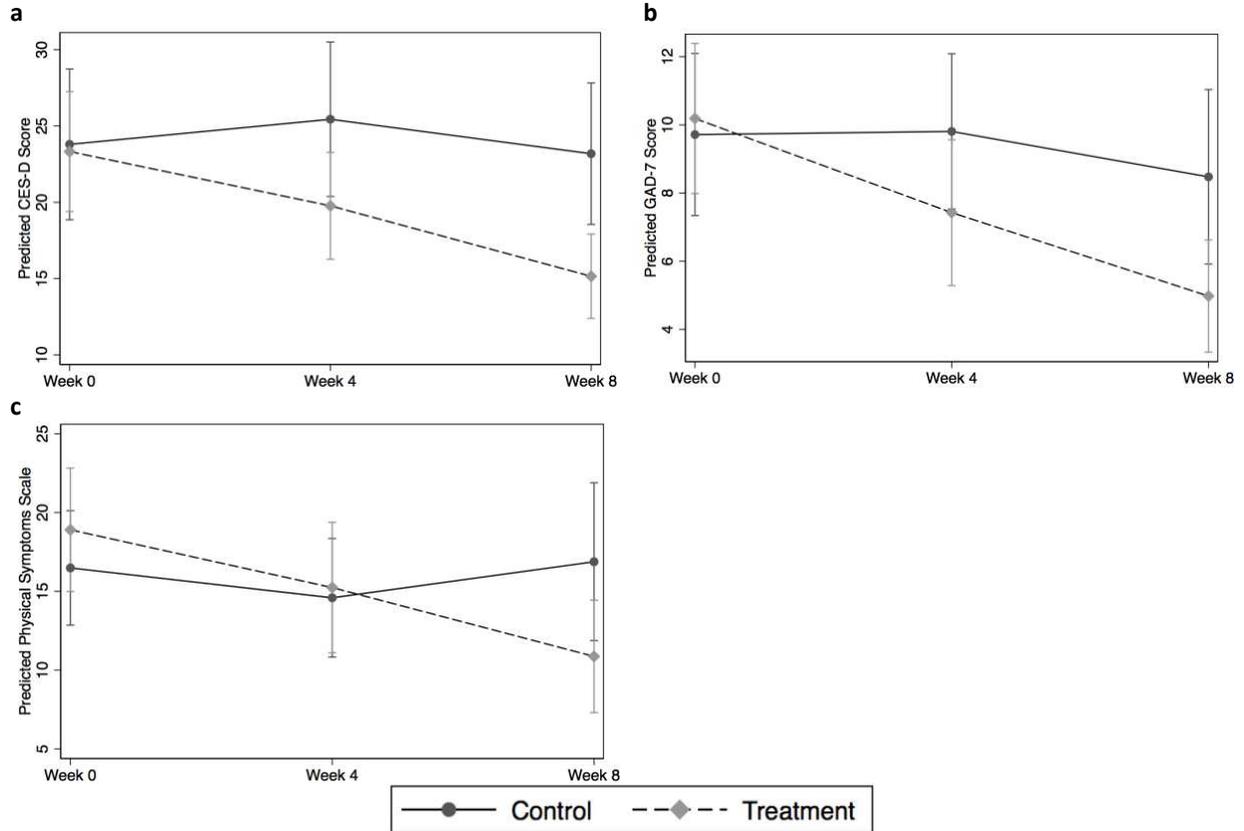


Figure 1. Predicted CES-D (a), GAD-7 (b), and Physical Symptoms (c) Scores with 95% Confidence Intervals

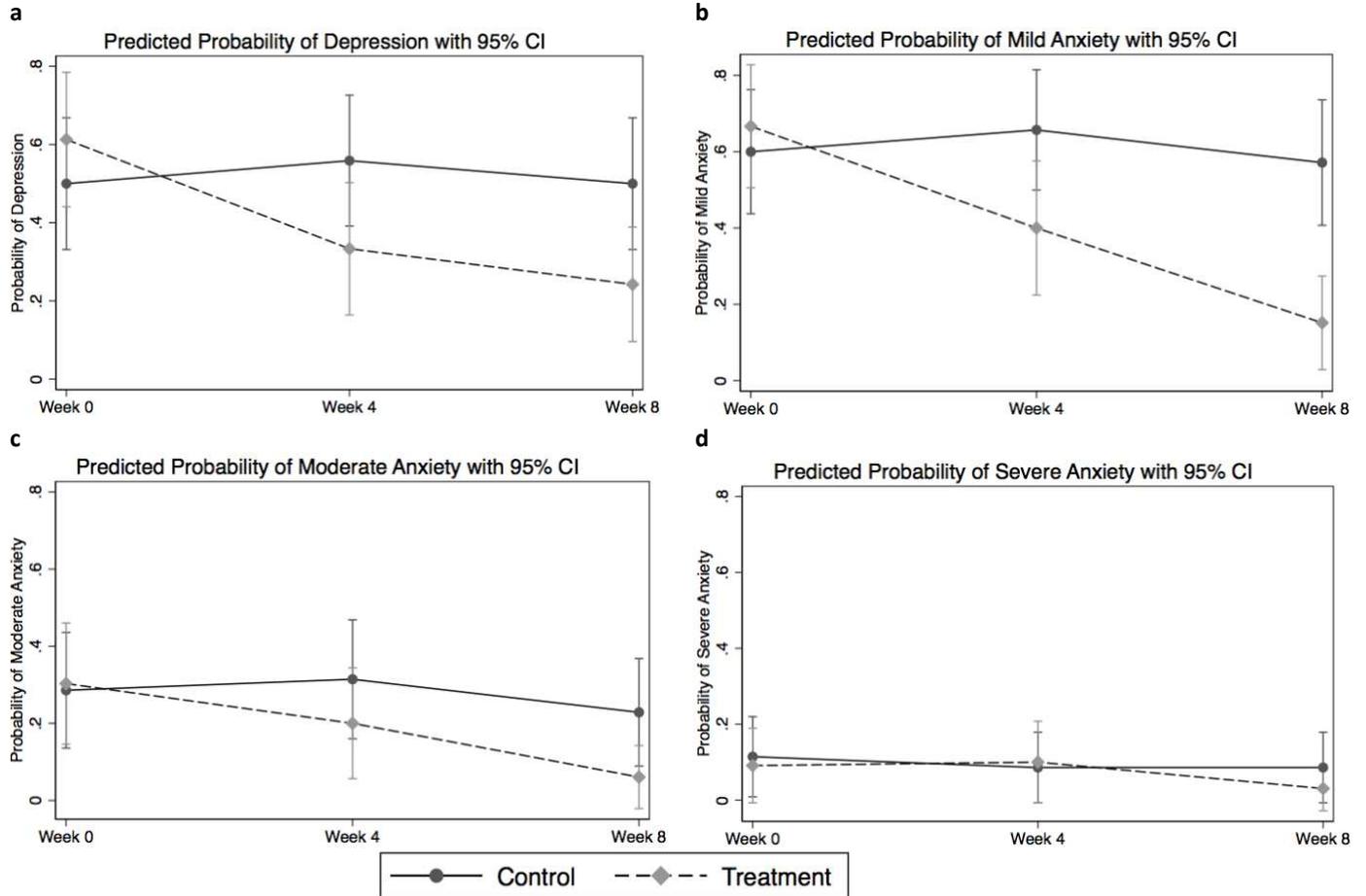


Figure 2. Predicted Rates of Scores Meeting Criteria for Depression (a), at Least Mild Anxiety (b), at Least Moderate Anxiety (c), and Severe Anxiety (d), with 95% Confidence Intervals

Table 6. Logit Models of Attrition by Survey

	Mid Survey	Post Survey	Mid Survey	Post Survey
Treatment	-2.166 (1.656)	-0.347 (1.367)	0.533 (1.923)	1.658 (1.638)
CES-D Scale _{t0}	-0.021 (0.054)	-0.016 (0.043)		
Treatment x CES-D Scale _{t0}	0.127* (0.066)	0.077 (0.058)		
Depression			-0.418 (1.491)	0.516 (1.438)
Treatment x Depression _{t0}			0.092 (1.464)	-1.535 (1.428)
GAD-7 Scale _{t0}	0.189 (0.153)	0.150 (0.131)		
Treatment x GAD-7 Scale _{t0}	-0.077 (0.118)	0.072 (0.120)		
Mild Anxiety _{t0}			-0.419 (1.726)	-1.233 (1.684)
Treatment x Mild Anxiety _{t0}			1.356 (1.562)	2.562* (1.457)
Moderate Anxiety _{t0}			2.397 (1.542)	1.469 (1.468)
Treatment x Moderate Anxiety _{t0}			0.895 (1.841)	2.058 (1.720)
Severe Anxiety _{t0} ¹			-	-2.943 (4.090)
Treatment x Severe Anxiety _{t0}			2.259 (2.038)	4.021* (2.112)
Physical Scale _{t0}	-0.097 (0.079)	-0.027 (0.067)	0.089 (0.130)	0.104 (0.113)
Treatment x Physical Scale _{t0}	-0.002 (0.050)	-0.081 (0.059)	0.011 (0.049)	-0.021 (0.052)
Leisure Time	0.070 (0.125)	0.052 (0.117)	0.123 (0.133)	0.049 (0.134)
Exercise Time	0.009 (0.178)	-0.025 (0.244)	-0.048 (0.170)	-0.036 (0.257)
Social Time	0.237 (0.156)	0.214* (0.129)	0.114 (0.160)	0.158 (0.130)
Male	0.427 (0.783)	1.017 (0.757)	0.286 (0.819)	0.499 (0.794)

	Mid Survey	Post Survey	Mid Survey	Post Survey
Age	-0.021 (0.084)	-0.167* (0.099)	-0.085 (0.089)	-0.254** (0.110)
White	0.301 (0.867)	-0.683 (0.803)	0.392 (0.996)	-0.627 (0.879)
CALS	0.549 (0.960)	0.990 (0.933)	0.892 (1.034)	0.937 (1.043)
CLAS	0.010 (0.982)	0.634 (0.938)	-0.033 (1.046)	0.411 (1.011)
PhD	-0.223 (1.050)	0.169 (1.009)	0.968 (1.092)	1.138 (1.120)
Constant	-3.100 (2.711)	0.436 (2.823)	-3.624 (3.298)	1.343 (3.353)
N	81	81	76	81
Pseudo-R ²	0.192	0.201	0.175	0.240

Note: *, **, and *** indicate significance at the 0.1, 0.05, and 0.001 levels, respectively.

¹No attrition occurred at the midpoint survey among those with GAD-7 scores associated with severe anxiety, so this group was dropped from the regression.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [SupplementaryMaterials.pdf](#)