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REVIEW

Effects of Mindfulness Meditation on College Student Anxiety: a Meta-Analysis

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Abstract

College student anxiety is a rising recurrent problem. It is the foremost diagnosed and treated mental health condition and has many negative consequences, including attrition and course failure. Mindfulness meditation (MM) is an approach to anxiety reduction comprised of self-regulation and orientation. Meta-analyses have been conducted on MM with adults and children, but not with college age students who are unique in that they have a distinctive set of stressors. Therefore, we examined the effects of MM on anxiety in college students by conducting a meta-analysis. We searched 11 electronic databases, hand searched select journals, and unpublished literature. We located 25 primary studies, providing 28 comparisons, with 1492 participants. The overall summary effect was .56 ($p < .001$). Major, level of study, MM practice outside of the intervention, and number of sessions moderated the effects of MM on anxiety. Future researchers should examine the specific needs of subgroups: men vs. women, and graduate vs. undergraduate students. Additionally, researchers should test interventions that fit the needs of today's college students, by limiting outside practice and offering a minimum of eight instructor-led sessions.

Keywords Mindfulness · Mindfulness meditation · Anxiety · Meta-analysis · Mindfulness-based stress reduction · Mindfulness-based cognitive therapy · State anxiety

Introduction

Anxiety is an indistinct sensation that is experienced when an individual is faced with long-term or excessive stress (Lazarus and Folkman 1984). Anxiety disorders are the most commonly diagnosed and treated mental health conditions on college campuses today (American College of Health Association 2015a, 2015b). Over the last 15 years, college students' reports of anxiety have nearly doubled and 21.9% have stated that anxiety has negatively impacted their education (American College of Health Association 2015a, 2015b). Researchers have concluded that high levels of anxiety in college students may negatively affect their memory, study habits, physical and mental health, and may cause avoidance and other ineffective coping strategies (Beddoe and Murphy 2004; Kang, Choi, & Ryu, Kang et al. 2009).

Mindfulness-based interventions (MBIs) are a well-researched psychological practice that is characterized by control of attention, awareness, acceptance, non-reactivity, and non-judgmental thoughts that are gained through the practice of meditation (Kabat-Zinn 2003; Malinowski 2013a, 2013b; Rapgay and Bystrisky 2009). Kabat-Zinn (2003) described mindfulness as "paying attention on purpose" or directing one's consciousness to thoughts, feelings, and emotions. Grossman and Van Dam (2011) stated that there are five features that signify mindfulness: constant unsystematic examination of experiences, awareness of each moment, non-judgmental acceptance, increased attention, and routine practice for enhancement. There are several types of MBIs; the most common and well-known are mindfulness-based stress reduction (MBSR) and mindfulness-based cognitive therapy (MBCT). Philosophically, MBCT and MBSR differ. MBSR is a combination of Buddhist Vipassana and Zen Buddhist traditions. The focus of Vipassana is developing awareness over time through systematic exercises that train one's mind towards awareness of physical sensations and life events

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(Gunaratana 2011). Zen Buddhism is a quest for focus of the mind, self-awareness, and enlightenment through self-discovery using a variety of meditation techniques (Kjellgren and Taylor 2008; Maupin 1962). The central meditation in Zen Buddhism is done while sitting on a meditation pillow with focus on posture and breathing. If extraneous thoughts arise, the practitioner should note they have occurred and return their attention to their posture and breathing (Kjellgren and Taylor 2008; Zen Buddhism 2017). MBCT encompasses MBSR but highlights self-management, control, and improvement (Chiesa and Malinowski 2011).

Recently, mindfulness has been examined to determine its association with anxiety. Researchers have repeatedly stated that those with high levels of mindfulness report lower levels of anxiety (Ghorbani, Cunningham, & Watson, Ghorbani et al. 2010; Masuda and Tully 2012; Weinstein, Brown, & Ryan, Weinstein et al. 2009). Additionally, a number of researchers used MBIs to determine its effects on college student anxiety. In a recent narrative review, researchers found that anxiety decreased when MBIs were used as an intervention (Bamber & Schneider, Bamber and Kraenzle Schneider 2016). The next step is to quantitatively analyze the effects of MBIs, taking into consideration the various intervention characteristics employed.

Prior researcher teams meta-analyzed the effects of MBIs on anxiety, but used youth or adult populations; each found that MBIs provided significant effects (Goyal et al. 2014; Khoury et al. 2013; Zoogman et al. 2014). In another meta-analysis, Regehr, Glancy, & Pitts (Regehr et al. 2013) examined several interventions, including MBIs that potentially reduced anxiety in university students. They examined MBIs separately from other interventions and found that the effects of MBIs were significant when compared to controls. Nonetheless, the researchers did not examine potential moderators, nor did they examine single group pre-post effect sizes.

Potential moderators are essential to explore because they may significantly impact the outcomes of MBIs. Graduate and undergraduate students, as well as male and female students, may respond differently to MBIs. No prior researchers meta-analyzed the effects of MBIs on anxiety in college students and explored moderators that may influence these effects. Therefore, the purpose of this meta-analysis was to examine the effect of MBIs on anxiety in college students. In addition, we will explore the following research questions: Do the effects of MBIs vary depending on intervention characteristics (e.g., number of sessions, length of time for each session, inclusion of yoga, training of facilitator, home practice sessions)? Do the effects of MBIs vary depending on participant characteristics (e.g., level of study, gender, age)? Do the effects of MBIs vary depending on design characteristics or publication status (e.g., randomized vs. self-selected, published vs. unpublished)?

Method

Inclusion/Exclusion Criteria

To be included, primary study researchers must have used mindfulness-based interventions with college students and measured anxiety as an outcome. Both undergraduate and graduate students were included. Primary studies were not excluded based on participant gender, age, or major. We included studies of both clinical (diagnosed with an anxiety disorder) and nonclinical student samples (investigator measured). To be included, studies had to be written in English. Studies in which researchers performed mood and/or stress inductions before initiation of the intervention were excluded because we wanted to examine anxiety in its natural (i.e., not induced) state. We included primary studies with two-group comparisons (MBI vs. control) as well as studies with pretest/posttest analysis of MBI (one-group MBI). For the two-group comparisons, we included studies with an MBI group and a no-treatment control group. For the pretest/posttest comparison, we included studies where researchers employed single group pretest/posttest designs. For studies with active control groups, we excluded them from the two-group comparison to produce a more precise estimate of the MBI effect size (Borenstein, Hedges, Higgins, & Rothstein, Borenstein et al. 2009), but used the MBI group in the pretest/posttest comparison ($s = 4$). We excluded studies in which researchers examined only trait anxiety given that trait anxiety is, by definition, innate and difficult to change (Brown and Cordon 2009; Treadway and Lazar 2010). Conversely, we included state anxiety and anxiety measures that did not delineate between state and trait.

It is important to reiterate that there are many variations of MBIs found in current research, which may differ significantly. Therefore, we included studies with MBIs that contained core constructs of mindfulness (i.e., attention, awareness, acceptance, non-reactivity, and non-judgmental thought), to ensure that we examine the true effects of mindfulness on college student anxiety. To determine if study interventions included core constructs of mindfulness, we read each article and coded specific intervention characteristics. We did not exclude studies with interventions that were labeled MBIs.

While we did not address the quality of the studies in our inclusion and exclusion criteria, we did examine ES differences across various indicators of quality. For example, we compared the ES of studies where researchers used randomization to those where researchers used self-selection. Additionally, we compared the differences between the country and settings in which the interventions took place. According to Borentstein et al. (Borenstein et al. 2009), comparing the differences between these subgroups allowed us to determine if the variation in study design was associated to the ES. Borenstein et al. (2009) purport that meta-analysis is able

to explore if the effect size is in response to the variation of study characteristics.

Search Strategy

Several electronic databases were searched through June 2016 to find primary studies, including PsychINFO (1967+), MEDLINE (1946+), CINAHL (1981+), Scopus (1832+), PubMed (1946+), Cochrane (1993+), Proquest Dissertation and Theses, Campbell Library (2000+), ERIC (1966+), Education Source (1929+), Academic Search Complete (1887+), and Educators Reference Complete (1932+). Search terms were created in consultation with a nurse librarian to gather as many articles as possible. They included "mindful*" AND "college OR universit*" AND "anxiety OR stress*." Truncating terms with an asterisk allowed every ending to the word. Subject headings were exploded to be as comprehensive as possible. We conducted a second systematic search, following the above methods, to ensure that any studies missed or published since the initial search were included in the analysis.

Data Extraction and Coding

A codebook was developed to extract and record data and moderator variables. Sections of the codebook included study, participant, and intervention characteristics, and anxiety outcome data. Study characteristics included assignment strategy (i.e., randomized, self-selected, or stratified randomization), publication status (published or unpublished), intervention setting, and country where the study was conducted. Participant characteristics included age, gender, level of study (graduate or undergraduate), and sample size for reported majors (nursing, medicine, psychology, business, etc.), and level of study (graduate vs. undergraduate). Intervention characteristics included yoga, journaling, outside practice, types of meditations (i.e., loving kindness, mindfulness, or insightful), discussions included, number of sessions, number of weeks, minutes per week, interventionist training/experience, and type of MBI used (i.e., MBSR, MBCT, or researcher modified). Finally, outcome data for anxiety of no-treatment control and MBI groups included means and standard deviations, *f*-statistics, *t*-tests, and associated *p*-values. In two studies, research teams used a three-armed randomized controlled design where they compared two or more MBIs to one no-treatment control group. In this case, anxiety outcome sample sizes for the each MBI comparison group was compared to half of the no-treatment control group participants to provide comparisons for each intervention group while not counting participants more than once.

Coding was conducted by two independent researchers. Once coding was completed, a research assistant reviewed all code sheets for differences. Differences in coding were discussed between researchers until consensus was reached.

Data Analyses

Coded data were double-entered and compared for discrepancies, which were then corrected. Effect sizes (ESs) were calculated for treatment versus control at post-intervention using comprehensive meta-analysis (CMA) software (version 3.3.07). We assumed that true ES varied from one study to the next due to sampling error (i.e., differences in participant characteristics and differences in intervention characteristics); therefore, we used a random-effects model which assumes that the true effects are normally distributed (Borenstein et al. 2009). Then to compute summary ES, CMA weights each study by the inverse of the within- and between-studies variance. Additionally, we ran Hedge's *g* calculations because they allow for corrections of biases due to small sample sizes. Confidence intervals (CI) were set at the standard 95% assuming normal distribution and allowing for 2.5% error at either end of the distribution (Borenstein et al. 2009). We examined heterogeneity across studies by inspecting the Forest plots and calculating the Q statistic which reflects total dispersion (weighted sum of squares). Also, we conducted T^2 (variance of true ESs) and I^2 (percent variability reflecting real ES differences) to further examine heterogeneity. The I^2 statistic is calculated using the ratio of excess dispersion to total dispersion. Next, we calculated the ES between anxiety pretests and posttests for the MBIs groups using single-group analyses. We also compared pretest and posttests of the no-treatment control groups. In the single group, pre-post ES calculations require correlational data which are often not reported; therefore, we conducted the single-group pre-post analysis assuming no correlation ($r = 0$) and high correlation ($r = .8$).

In addition, moderator analyses were conducted on participant, intervention, and design characteristics to explore potential causes of heterogeneity (Borenstein et al. 2009). Categorical moderators were analyzed using the analogue to analysis of variance. Meta-regression was conducted on continuous moderators, which is analogous to multiple-regression (Borenstein et al. 2009).

Finally, to examine potential publication bias, we examined the standard error funnel plot, Egger's regression, Begg and Mazumdar rank test, and Duval and Tweedie's trim and fill. Egger's regression calculates the inverse of the standard error, where the intercept parallels to a slope in a weighted regression. The Begg and Mazumdar Rank test calculates the rank order correlation between treatment effects and variances. Duval and Tweedie's trim and fill estimates the number of asymmetric studies and removes them from the funnel plot. The remaining studies are used to determine the true center of the funnel plot through calculating the ES at each point, until the funnel plot is symmetrical. Once completed, the removed

studies are replaced and mirrored studies are added to the other axis of the funnel plot for symmetry. The ES and variance are recalculated based on the new filled funnel plot. Publication bias is suspected when the overall ES is significantly decreased (Borenstein et al. 2009; Duval & Tweedie, Duval and Tweedie 2000).

Results

The initial electronic database search resulted in 405 articles, including seven dissertations. Hand, index, and ancestry searching resulted in four additional studies. Once duplicates were removed, 176 studies remained. After the first author reviewed abstracts for inclusion criteria, 44 studies remained, which were read in their entirety to determine if all inclusion criteria were met. This resulted in an initial inclusion of 24 studies. Three were missing pretest means, posttest means, standard deviations, *f*-statistics, or *t*-tests necessary for effect size or comparison analysis. These authors were contacted and either did not respond or reported that their data were lost, leaving 21 studies. A second search was conducted to lessen the chance of inadvertently omitting pertinent research. The search resulted in 213 studies; after removing duplicates, 38 remained. Likewise, abstracts were screened, 18 studies were excluded. The remaining 20 were read for inclusion; additional four studies met inclusion criteria. In addition, four researchers that are prolific in the MBI literature were contacted to determine the availability of unpublished data (i.e., prepublication data, conference reports) that met inclusion criteria. This did not result in additional data. Finally, a total of 25 studies met inclusion criteria and were included in this meta-analysis (see Fig. 1).

Descriptive Statistics

The 25 primary studies ($s = 25$) provided 28 comparisons ($k = 28$). Sample sizes ranged from 6 to 162, with a total of 1492 participants. Of those, 747 participants were in the MBI groups (M = 26.7, SD = 25.1) and 745 participants in the no-treatment control groups (M = 29.8, SD = 30.04). Most studies were conducted in the USA ($s = 15$). Other locations included the United Kingdom ($s = 4$), China ($s = 1$), Australia ($s = 1$), Korea ($s = 2$), Spain ($s = 1$), and Thailand ($s = 1$). Finally, 22 studies were published in journals and three were dissertations.

Researchers recruited undergraduates in ten of the studies, graduate students in five, and a combination of undergraduate and graduate students in nine studies. In one study, students were not classified. The total mean age was 24.3 (SD = 4.2) years, MBI participants' mean age was 25.1 (SD = 5.1) and control mean age 24.7 (SD = 4.1) years. Across all studies, mainly females participated (80%). Researchers did not report gender in only one study. Researchers specified major in 14 of the 25 studies. Of these, the medical professions were the most common majors (nursing $n = 213$, medical $n = 461$, pre-med $n = 35$).

MBIs varied widely among the studies, with most researchers modifying MBSR, MBCT, or creating their own interventions to fit the scope of their study ($s = 14$). MBSR was the next most common intervention used ($s = 7$), followed by MBCT ($s = 2$), and a combination of interventions ($s = 2$). MBI interventions ran for a mean of 7.4 weeks (SD = 3.2), with a mean of 10.3 (SD = 8.4) sessions. These sessions comprised of a mean of 98.2 min per week (SD = 55.6). Despite the various number of sessions, minutes per week were consistent across the studies; likewise, interventions with a greater number of sessions continued for a greater number of weeks. To examine the effect of the highest number of sessions, we removed studies with the highest sessions from descriptive analysis and found no appreciable change in means (Table 1). The most common types of meditation were mindful meditative techniques ($s = 25$) with yoga included in 13 of the interventions. Discussions during the interventions mainly consisted of mindfulness practices and daily mindfulness ($s = 16$) and stress or stress symptoms ($s = 9$). Researchers expected meditation practice outside of the intervention in 12 studies and journaling in 6 studies.

Overall Summary Effect

The overall ES comparing MBIs with their no-treatment controls was large (.56; SE = 0.07; 95% CI 0.42–0.70; $Z = 7.99$, $p < .001$) with significant heterogeneity ($Q = 102.3$, $df = 24$, $p = <.001$, $I^2 = 76.6\%$) and sizeable variance in true effects ($T^2 = 0.08$). Figure 2 presents the forest plot of individual study ESs; the squares denote the direction and magnitude of the effects as the size of each square represents the weight of the study. Pre-post MBIs ES showed significant decreases in anxiety for both the correlated 0.8 (0.54, $p = .003$) and uncorrelated 0.0 (0.52, $p = .004$, Table 2). There was a small but significant reduction in control group anxiety pre-post comparisons, with a small ES when correlated and not correlated ($r = 0.08$, ES = 0.25, $p = .003$; $r = 0.0$, ES = 0.23, $p = .003$; Table 2). The overall summary ES supports that MBIs are effective in reducing college students anxiety ($Z = 7.98$, $p < .001$). A majority of the studies ($s = 17$) had significant ESs ($p < .05$) and most of these ($s = 16$) had an ES > 0.39.

Publication Bias

Upon visual inspection of the standard error funnel plot, there was some asymmetry with fewer studies to the far lower left, which may suggest publication bias (Sterne et al. 2011); in particular, there were no publications of studies with small sample sizes and no effects (Fig. 3). Egger's regression

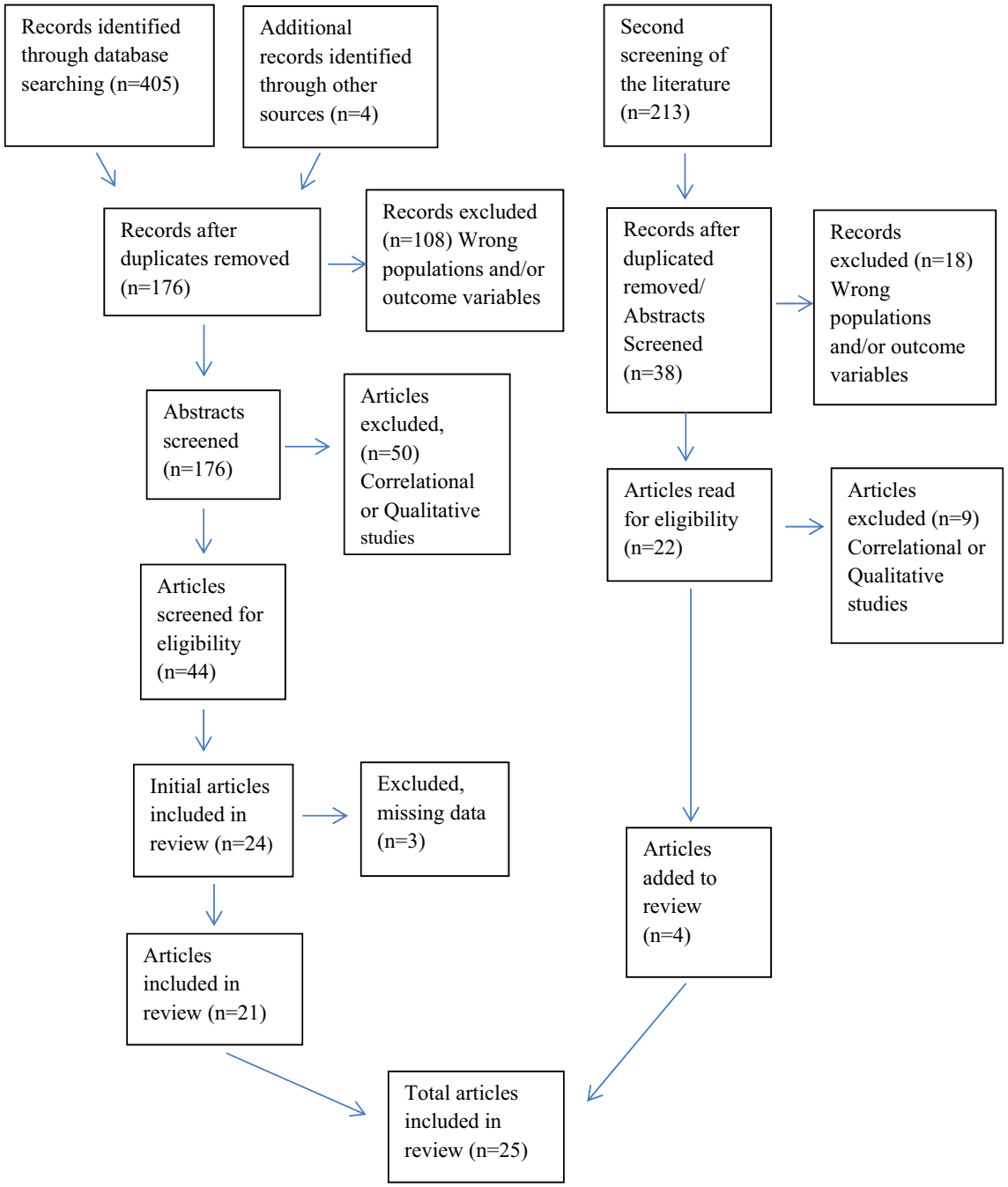


Fig. 1 Search results

intercept resulted in an intercept of 2.33 (95% CI .23–4.44; $t(23) = 2.29$; $p = .015$) which indicated that there was publication bias. The Begg and Mazumdar Rank test suggested no publication bias with a Kendall's tau of 0.06 ($p = .328$). Using Duval and Tweedie's trim and fill random effects model, we found that no studies were trimmed, which resulted in no change of the overall ES, suggesting no publication bias. Thus, given the contradictory bias results, the findings of this meta-analysis should be interpreted conservatively.

Moderators

Study characteristics: ESs were not significant across study characteristics (assignment strategy, publication status, intervention setting, or country; Tables 3 and 4).

Participant characteristics: Participant age was not related to MBIs ES. While not significantly different, women receiving MBIs showed a large ES, which is greater reduction in anxiety, than men. MBIs were significantly more effective in

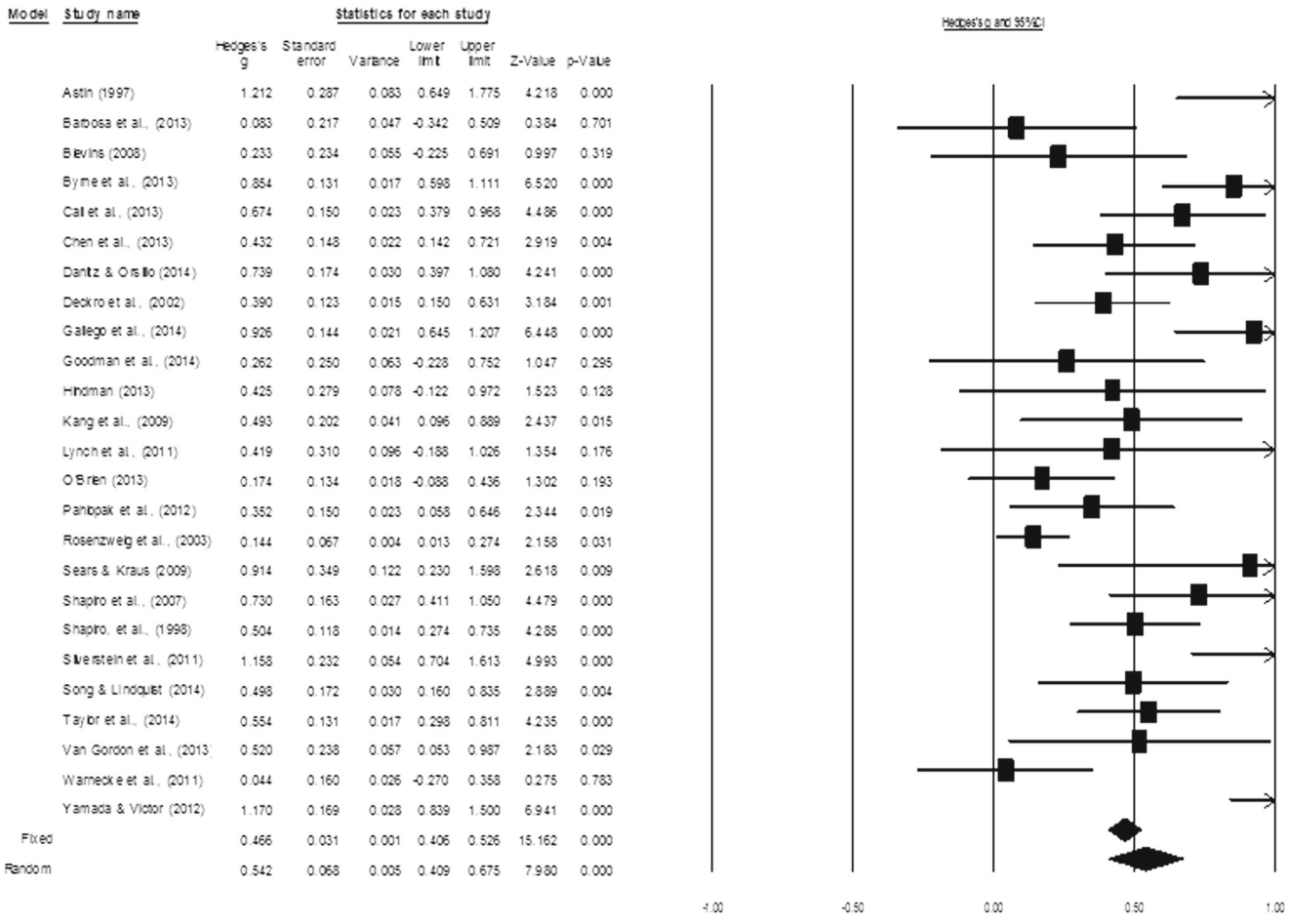
Table 1 Sessions descriptive analysis

Interventions with > 30 sessions included	*s*	*k*	Min	*Q*1	Medn	*Q*3	Max	Mean	SD
Minutes each week	25	28	12.5	60	102.5	120	210	98.2	55.6
Total minutes	25	28	48	202.5	727.5	960	2160	672.3	513.7
No. of sessions	25	28	1	6.25	8	8	36	10.3	8.4
No. of weeks	25	28	1	6	8	8	15	7.4	3.2
Interventions with > 30 sessions excluded	*s*	*k*	Min	*Q*1	Medn	*Q*3	Max	Mean	SD
Minutes each week	23	26	12.5	60	102.5	120	210	98	53
Total minutes	23	26	48	187.5	8	960	1680	629	435
No. of sessions	23	26	1	6	7.85	8	28	7.85	4.9
No. of weeks	23	26	1	5.75	8	8	12	6.92	2.7

s = number of studies; *k* = number of comparisons providing data; *Mi* = minimum, *Q*1 = first quartile; Med = median; *Q*3 = third quartile; SD = standard deviation

undergraduate students than graduate students ($Q = 10.4$, $df = 1$, $p = .001$) having a large effect in decreasing undergraduate students anxiety (0.63, $p < .001$), but only a small to medium effect in graduate students (0.24, $p = .006$).

Intervention characteristics: When MBI researchers did not expect outside meditation practice, students showed greater reductions in anxiety (.63, $k = 14$, $p = .008$) than when MBI researchers expected practice outside of the intervention time



Summary Effect
ES =.542 95% CI: .409–.675, $p < .001$

Fig. 2 Forest plot Hedge's *g*

Table 2 Random-effects model of MBI pre-post comparisons effect sizes

	k	ES	*p*(ES)	95% CI	SE	*Q*	*p*(*Q*)	I^2
MBI group pretest vs. posttest ($r = .8$)	28	.54	.003	.43–.65	.06	139.36	.000	80.63
MBI group pretest vs. posttest ($r = 0$)	28	.52	.004	.4–.63	.06	31.75	.24	14.96
Control group pretest vs. posttest ($r = .8$)	24	.25	.003	.15–.35	.05	89.92	.000	74.42
Control group pretest vs. posttest ($r = 0$)	24	.23	.003	.13–.34	.05	18.82	.71	.000

k = number of comparisons providing data; ES = effect size; SE = standard error; CI = confidence interval

period (0.34, $k = 13$, $p = .006$) and these differences were significant ($Q = 4.457$, $df = 1$, $p = .035$; Table 3). Yoga, journaling, intervention type, and discussions were not significant. Intervention characteristics varied widely with regard to weeks, number of sessions, and minutes participants met each week. Number of sessions moderated the effects of MBIs on anxiety ($Q = 6.79$, $df = 1$, $p = .0092$; Table 4) with more sessions indicating a stronger ES, that is greater reduction in anxiety. Type of intervention (MBSR, MBCT, or researcher modified/created) was not significantly different. Additionally, total number of minutes of MBI, number of weeks, and minutes of MBI per week were not related to the effects of MBI on anxiety (Table 4).

Discussion

Our initial findings are promising. Overall, when compared with controls, MBIs had a large and significant effect in decreasing college students' anxiety. Most studies had significant ESs, and of these, most had moderate to large ESs. MBI groups' pre-post comparisons also had large significant reductions in anxiety. Pre-post control group comparisons were also significant but showed reductions in anxiety; though anxiety did not significantly change in control groups across studies.

While our findings support the effects of MBIs on anxiety in college students, we note that some publication bias is possible. Publication bias is a major concern for meta-analyses because studies with significant results are more likely to be submitted and published making them more likely to be retrievable for meta-analysis. We found some asymmetry in the funnel plot which indicated that we found no studies with small sample sizes and nonsignificant effects. In order to account for the asymmetry and possible bias, a Duval and Tweedie's trim and fill random effects model was run which resulted in no change in the overall effect size; which supports that no publication bias exists However, publication bias is still possible and results should be interpreted with this in mind.

In prior meta-analyses, researchers who explored the effects of MBIs, also examined other stress reduction interventions, used a youth-based population, or examined the effects of MBIs in adult clinical populations (Chiesa and Serretti 2009; Goyal et al. 2014; Khoury et al. 2013; Regehr et al. 2013; Zoogman et al. 2014). Therefore, this meta-analysis is novel and provides supportive evidence for the use of MBIs on college student anxiety. Despite the differences, our overall ES findings were in accordance with the results from previously published meta-analyses. Researchers reported that MBIs significantly reduced anxiety in both clinical and nonclinical samples in the youth population and reduced overall anxiety in adult clinical and nonclinical populations. We added to this literature by showing that MBIs are effective for reducing anxiety in college students as well.

Also novel was our exploration of moderator variables. We found no study characteristics (assignment strategy, country,

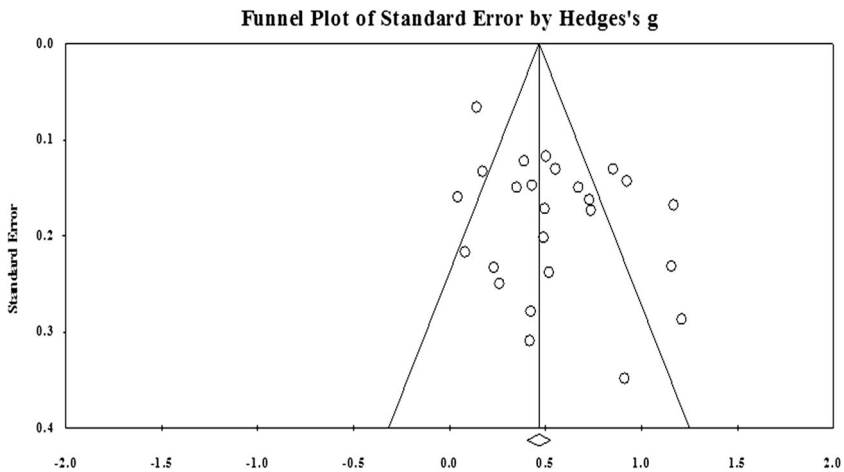


Fig. 3 Standard errors funnel Hedge's *g*

Table 3 Categorical moderator results comparing MBI versus control groups

Moderator	*k*	ES	SE	Var	95% CI	*Z*	*p*(*Z*)	Q_{bet}	$p(Q_{bet})$
Participant characteristics									
Gender								.801	.371
Male	8	.339	.171	.029	.004–.674	1.982	.048		
Female	16	.510	.084	.007	.345–.675	6.053	.000		
Level of study*								10.401	.001
Graduate	8	.240	.087	.008	.070–.410	2.754	.006		
Undergraduate	15	.625	.082	.007	.464–.786	7.602	.000		
Intervention characteristics									
Intervention type								1.692	.639
MBSR	7	.474	.141	.020	.198–.750	3.363	.001		
MBCT	2	.740	.188	.035	.372–1.108	3.944	.000		
Combination of MBSR and MBCT	2	.388	.385	.148	−.366–1.143	1.009	.313		
Other	14	.631	.130	.017	.376–.886	4.849	.000		
Outside practice*								4.457	.035
Expected	11	.367	.087	.008	.196–5.38	4.210	.000		
Not expected	12	.633	.091	.008	.455–.811	6.969	.000		
Moderator	*k*	ES	SE	Var	95% CI	*Z*	*p*(*Z*)	Q_{bet}	$p(Q_{bet})$
Journaling								.483	.487
Required	7	.509	.114	.013	.286–.733	4.475	.000		
Not required	8	.626	.123	.015	.385–.867	5.094	.000		
Yoga								.455	.500
Included	12	.525	.106	.011	.318–.732	4.967	.000		
Not included	13	.644	.140	.020	.369–.919	4.589	.000		
Mindful meditations								.185	.667
Included	25	.636	.089	.008	.461–.811	7.138	.000		
Not included	1	.374	.603	.363	−8.07–1.555	.620	.535		
Insightful meditations								.106	.745
Included	5	.575	.201	.040	.182–.969	2.867	.004		
Not included	21	.648	.101	.010	.451–.846	6.443	.000		
Relationship/loving kindness meditations								1.002	.317
Included	12	.546	.105	.011	.340–.751	5.212	.000		
Not included	14	.718	.136	.019	.451–.985	5.269	.000		
Discussions: stress response								.127	.722
Included	10	.639	.100	.010	.442–.835	6.375	.000		
Not included	10	.584	.116	.013	.357–.811	5.037	.000		
Discussions: mindfulness practices								.008	.927
Included	17	.618	.080	.006	.461–.775	7.702	.000		
Not included	3	.595	.232	.054	.140–1.050	2.563	.010		
Discussions: techniques								.007	.932
Included	5	.625	.136	.018	.359–.891	4.604	.000		
Not included	15	.611	.091	.008	.432–.790	6.686	.000		
Discussions: self and relationships								.510	.475
Included	7	.515	.160	.025	.202–.828	3.227	.001		
Not included	13	.645	.086	.007	.476–.813	7.482	.000		
Study characteristics									
Moderator	*k*	ES	SE	Var	95% CI	*Z*	*p*(*Z*)	Q_{bet}	$p(Q_{bet})$
Study design								4.316	.116

Table 3 (continued)

Control group	17	.675	.096	.009	.486–.864	7.004	.000		
Usual care group	6	.330	.135	.018	.065–.595	2.442	.015		
Intervention comparison groups with control	2	.567	.390	.152	−.197–1.330	1.455	.146		
Assignment strategy								.594	.743
Randomization	12	.606	.090	.008	.429–.783	6.700	.000		
Stratified Randomization	4	.480	.151	.023	.184–.777	3.179	.001		
Self-selected	9	.638	.207	.043	.233–1.044	3.085	.002		
Publication status								1.662	.197
Published	22	.614	.095	.009	.428–.801	6.451	.000		
Not published	3	.313	.214	.046	−.106–.732	1.462	.144		
Setting								4.567	.102
Academic center	23	.592	.091	.008	.413–.771	6.490	.000		
Medical center	1	.854	.227	.052	.410–1.299	3.764	.000		
Home	1	.045	.304	.093	−.551–.641	.147	.883		
Country								6.049	.418
USA	15	.643	.134	.018	.381–.905	4.816	.000		
UK	4	.589	.164	.027	.268–.910	3.598	.000		
China	1	.434	.276	.076	−.108–.976	1.570	.117		
Australia	1	.045	.304	.093	−.551–.641	.147	.883		
Thailand	1	.348	.364	.133	−.365–1.062	.957	.339		
Korea	2	.496	.241	.058	.024–.968	2.060	.039		
Spain	1	.926	.249	.062	.438–1.414	3.723	.000		

k = number of comparisons providing data; ES = effect size; SE = standard error; Var = variance; CI = confidence intervals; Q_{bet} = between study variance

*Moderates MBI on anxiety

setting, or type of control group) to moderate the ESs of MBIs on anxiety. Several intervention characteristics were not significant, including yoga, journaling, intervention type, and discussions. MBSR and MBCT are structured and well researched MBIs. We expected these interventions to be more effective than other MBIs, such as researcher-created interventions. One explanation for no significant differences in structured interventions (MBSR/MBCT) and researcher-created interventions may be the limited number of studies across this comparison. Another explanation might be that any meditation at all will help college students manage their anxiety. Another possibility is that MBSR and MBCT require a significant amount of time and college students may find that prospect overwhelming, causing ambivalence and further anxiety (Center for Mindfulness in Medicine, Health Care, and Society 2014). Additionally, despite researchers' emphasis on relationship/loving kindness and insightful meditations, these aspects of mindfulness meditation interventions did not influence MBIs' effect on anxiety. This lack of effect could be attributable to the small sample of studies with moderator data.

Surprisingly, interventions that did *not* expect home meditation practice showed greater significant decreases in anxiety. We expected that home practice would have greater effects. Additionally, our findings suggest that researchers who expected home practice lessened the effect of MBIs. One explanation might be that college students feel overwhelmed, doubtful, hesitant, anxious, and stressed at the prospect of adding MBI practice into their daily routines. Researchers reported that students believed they did not have time or found it arduous to include

Table 4 Continuous moderator results comparing MBI versus control groups

Moderator	*K*	Slope	SE	Tau^2	Q_{model}	*p*(slope)
Participant characteristics						
Mean age	21	−.43	.025	.07	.19	.667
Intervention characteristics						
Number of MBI sessions*	25	2.61	.0101	.058	6.79	.0092
Average minutes per week	25	−1.68	.0016	.076	2.81	.094
Dose (total time received in minutes)	25	−.82	.0002	.08	.67	.4123
Weeks of MBI intervention	25	1.83	.028	.09	3.34	.0675

k = number of comparisons providing data; SE = standard error

*Moderates MBI on anxiety

MBI, which resulted in feeling ambivalent about meditation (Birnbaum 2008; Parish 2011; Shonin et al. 2013; Stew 2011). These perceptions may potentially explain why not including outside meditation practice was more effective.

MBIs with a greater number of sessions showed greater reductions in anxiety than studies with fewer MBI sessions. Interventions with eight or more sessions had greater ESs than those with less than eight sessions. These findings are consistent with Khoury et al., (Khoury et al. 2013) who reported that treatment duration moderated the effects of MBIs on anxiety. Actual time spent meditating (minutes per week, total minutes, and number weeks of MBI) was not significant. Only the total number of sessions was important. Two studies that included 30 or more sessions, had very large ESs again supporting the importance of long-term meditating. In spite of this, eight sessions is a practical intervention for initial training of college students. Future researchers should conduct a randomized-controlled trial (RCT) to compare varying numbers of MBI sessions.

Undergraduate students were more likely than graduate students to report significant effects. One explanation might be that undergraduate students report higher levels of stress and anxiety than graduate students and therefore experience a greater reduction in their perceptions of stress and anxiety (American College of Health Association 2015a, 2015b). This finding parallels previous meta-analysis findings where Zoogman et al. (2014) reported that clinical samples had greater benefit from MBIs than the healthy population. Another possibility might be that graduate students are more experienced at dealing with school stressors than undergraduate students thereby experiencing less anxiety with stressors. Additionally, graduate students may have a wider array of responsibilities, such as, children, employment, and financial obligations, which inhibit them from fully engaging in the mindfulness interventions. Another potential explanation is sample size; there were more than twice as many undergraduate students as graduate students included in the studies.

It was surprising to find that gender did not moderate the effects of the MBIs. One explanation may be that more female students participated in MBI research than their male counterparts. Males and females often perceive anxiety differently; women report anxiety more frequently than males (Head, Head and Lindsey 1983). de Vibe et al. (2013) reported that women (not men) had greater reductions in stress and significantly increased mindfulness scores after a an MBI. The significant variance between these populations could have confounded results. Future researchers might specifically examine gender differences.

Implications for Research and Practice

Several gaps remain in the MBI research. While this meta-analysis focused on college student anxiety, stress and anxiety are intertwined and mindfulness is thought to affect each. If stress is perceived and the person is unable to cope, anxiety is a reaction to that stress (Hughes 2005; Kang et al. 2009). Future researchers might conduct a meta-analysis on the effects of MBIs on stress in college students.

We did not examine the effects of MBIs on overall mindfulness. Future researchers might examine the mediating and moderating role of state and trait mindfulness using meta-analytic techniques. These relationships require further exploration.

Furthermore, outcomes in outside practice should be explored further. Outside practice would lend itself well to a randomized controlled trial in which comparisons are made between students who are expected to do outside practice and those who are not.

Our results could lead to future MBIs specifically designed for college students. Researchers might consider conducting RCTs to compare effects of various content, sessions and structures using MBI. An example intervention could last 8 weeks and meet weekly. Each weekly session could last 45 min, with 30 min of meditation followed by a brief 15-min question-and-answer session. This could be compared to similar interventions, where all contain the same content, but lasts 4 and 12 weeks in place of 8. Additionally, because our results indicated that outside practice was not effective in increasing the effects of MBIs on anxiety, students would not be expected to practice outside the sessions. Students could be encouraged later as they become more comfortable and confident in their MBI abilities.

Limitations

One limitation in this meta-analysis is the small number of studies that met our inclusion criteria. Additionally, there was significant heterogeneity among studies. In addition, few researchers provided moderating data. Thus, findings should be interpreted with care. Because of missing moderator data, results should be interpreted with caution due to the possibility of type II errors.

Conclusion

Overall, when compared with controls, we found that MBIs reduced anxiety in college students had a large (0.56) significant effect. Additionally, we concluded that the greater the number of MBI sessions, the greater the effects. MBIs with expected outside practice (i.e., at home) had lower effects on anxiety than MBIs with no outside practice.

Practitioners might use interventions that emphasize mindfulness techniques without outside meditation practice and have at least eight sessions. MBIs for college students should be flexible in order to encourage participation and eliminate ambivalence. Researchers might explore the specific needs of

subgroups: men vs. women and graduate vs. undergraduate students. Given that anxiety in college students is on the rise, it is essential to further explore the use of MBIs in this specific population.

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Compliance with Ethical Standards

Ethical Approval This article did not contain human participants or animals.

Conflict of Interest Author Dr. Mandy Bamber declares that she has no conflict of interest. Author Erin Morpeth declares that she has no conflict of interest.

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