An Online Mindfulness Intervention to Reduce Stress and Anxiety Among College
Students

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I couldn't have finished this without the help of my wife Emily Meisler and my daughter Layla. Drs. Patricia Frazier, Moin Syed, Rich Lee and Cynthia Gross were also all invaluable in the completion of this dissertation.

Dedication

This thesis is dedicated to my wife Emily without whom it never would have happened.

Abstract

This study evaluated the efficacy of two different web-based stress management programs among college students at a large Midwestern university. After completing the pretest, students ($N = 401$) were randomly assigned to a Mindfulness plus Present Control intervention, a Mindfulness only intervention, or a Stress-information only comparison group. Primary outcomes were stress, anxiety, depression, perceived stress and worry; hypothesized mediators of intervention efficacy were rumination, mindfulness and present control. Self-report measures were completed online at pre-intervention, post-intervention, first follow-up (2-3 weeks postintervention) and second follow-up (4-5 weeks postintervention). Ninety percent of the sample ($n = 365$) completed the pretest and comprised the intent-to-treat sample. Linear mixed modeling was used to assess significant change over time and hierarchical regression was used to test for mediation. Participants in all three groups reported significant decreases in all five primary outcomes across all time points (within group $d's = -.15$ to $-.56$). All time by intervention group interaction effects were non-significant suggesting that the three conditions were equally effective. With regard to the mediators, participants reported significant increases in present control and mindfulness and significant decreases in rumination from baseline to post-intervention and both follow-ups (within group $d's = .01$ to $.71$). There was one significant time by intervention group interaction effect in the analyses assessing change over time in the mediators specifically indicating a between-group difference in changes in rumination, $F(8, 973) = 3.73$, $p = .0003$. In this case, the Mindfulness plus Present Control group reduced rumination significantly more than the comparison group.

Because there were few differences across conditions, mediation analyses were performed collapsing across conditions. In general, changes in present control were associated with changes in depression and changes in rumination were associated with changes in worry and perceived stress at the second follow-up controlling for baseline scores. Limitations and future direction are discussed.

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Introduction

Arnett (2000) described 'emerging adulthood' as a transitional stage between adolescence and adulthood when 18-25 year olds face unique challenges and developmental tasks. Emerging adults must employ skills to establish and maintain newfound romantic relationships, independence from parents, and burgeoning work identities, which can be stressful and anxiety-inducing (Meadows, Brown & Elder, 2006). Adapting to life in a university setting is one developmental task that many emerging adults face. Many students struggle to live on their own, create new social networks, and manage classes, exams and the mastering of new knowledge to meet personal goals. These transitions are stressful to some and can lead to mental health problems including depression and anxiety (Dyson & Renk, 2006). Given that many counseling centers around the nation find it difficult to meet students' mental health needs (NSCC, 2012), and that many university students are reluctant to engage mental health services due to concerns about stigma and privacy, there is a growing need for discreet, feasible and effective interventions to help students cope with stress on campus (Robotham & Julian, 2006). Because 95% of emerging adults have access to the internet, online interventions offer an opportunity to deliver private and effective assistance to students suffering from stress and its attendant negative mental health outcomes (Lenhart et al., 2011). This paper will briefly review the literature on the prevalence and negative outcomes associated with stress experienced in college as well as assess the extent to which internet-based interventions (IBIs) offer an alternative or adjunctive treatment to conventional mental health services in college settings. The intent of this research is to assess the efficacy of

an inexpensive online intervention to reduce stress and improve mental health for students currently enrolled in college.

Prevalence of Stress among College Students

Undergraduates today report experiencing a considerable degree of stress. The American College Health Association's National College Health Assessment (NCHA), a survey of more than 157 post-secondary institutions and 98,050 students, found that 53% of students reported feeling either 'more than average' or 'tremendous' levels of stress in the last 12 months (ACHANCHA, 2012). Additionally, over half the sample reported feeling overwhelmed by all they had to accomplish at school in the last two weeks with similar numbers reporting that they were frequently exhausted. Earlier iterations of the NCHA illustrated that students' stress levels seem to be holding steady over the last several years, with between 50% and 53% of students reporting 'more than average' or 'tremendous' levels of stress (ACHANCHA, 2011, 2010, 2009). This is in line with earlier data suggesting that 52% of college students reported moderate to severe stress over the course of a typical semester (Hudd et al., 2000). See Appendix A for more information on the prevalence of stress in college.

The Negative Consequences of Stress

The stress response in humans is mediated via the hypothalamus pituitary adrenal (HPA) axis which, when activated, produces glucocorticoids that regulate the fear response (Gunnar & Quevedo, 2007). Chronic activation of the HPA axis and the chronic suppressive effects of high amounts of glucocorticoids in the brain can have negative effects on physical and mental health leading to the development of pathological conditions such as anxiety, phobias, depression and post-traumatic stress disorder, in

addition to numerous physical illnesses such as reduced immune system functioning and insulin resistance (Gunnar & Quevedo, 2007; McEwen, 2003). As stress can negatively impact mental and physical health in college students, the following sections will address each of those domains.

Mental health. A brief review of existing literature demonstrates that stress can take a heavy toll on university students' mental health. Andrews and Wilding (2004) found that students who experienced various stressors, including financial difficulties or personal illness, were three times as likely to become depressed. Additionally, relationship difficulties, close other's illness or death, and financial difficulties were all significantly related to clinically-relevant levels of anxiety. Students who said they experienced relationship difficulties were twice as likely as others to report anxiety by mid-way through their first semester. Depression also predicted difficulties with exam performance. Similarly, other research (Chang, 2001) found a relationship between life stress and subsequent depressed mood in students ($r = .51$). Moreover, a path analysis examining potential mediators between life stress and depressed mood found that there was a considerable decrease in life stress's influence on dysphoria after controlling for self-concept and self-esteem; however, life stress still exerted a significant direct influence on depressed mood ($b = .27$). Dyson and Renk (2006) found significant relationships between family life stressors and depression ($r = .31$) and college stressors and depression ($r = .40$) for women but not for men.

Physical health. There is also ample evidence that stress is negatively associated with college students' physical health. Edwards et al. (2010) discovered that chronic stress in university students was related to physical health symptoms ($r = .40$) including

nausea, racing heart, headaches and many other symptoms as well as increased visits to the doctor. Moreover, stress is associated with an adverse effect on physical health. For instance, stress was associated with unhealthy food consumption (e.g., soda, candy), a reduction in healthy food consumption (e.g., fruits and vegetables), and reduced exercise and sleep (Hudd et al., 2000). Other research revealed that students who experienced 3 or more stressors were more likely to engage in unhealthy behaviors across all domains assessed including tobacco use in the last 30 days, binge drinking in the last 2 weeks, marijuana use in the last 30 days, high credit card debt in the last month and any gambling in the past 12 months (Lust & Golden, 2012). Taken as a whole, it is clear that stress can lead to a variety of negative outcomes for university students. See Appendix B for more information on the relations between stress and mental and physical health among students.

Common Stressors among College Students

The kinds of stressors college students encounter on campus are manifold. Certainly, trauma can be considered a form of stressor, indeed a severe one, and the data suggest that students experience them frequently. Frazier et al. (2009) found that 21% of undergraduate students experienced a trauma within the previous 2 months during college. Specifically, the most common traumatic event experienced was the unexpected death of a close friend or family member. Other common events included a loved one surviving a life-threatening event, motor vehicle or other accidents, and unwanted sexual attention. The data also showed that women reported more traumatic events than did men. As a result, students who experienced traumas at college were more likely to report symptoms of Post Traumatic Stress Disorder (PTSD).

Less severe, but still deleterious, stressors are more commonly reported by university students. Survey data mentioned earlier showed that 45% of students classified academics as "traumatic or very difficult to handle" in the last 12 months (ACHANCHA, 2012). Using the same time-frame and phrasing, 25% of students reported struggling with career related issues, 32% reported difficulty with intimate relationships, 28% reported problems related to their family and 34% reported financial difficulties.

Prevalence of Mental Health Problems on Campus

As there is clear evidence that stress is associated with poorer physical and mental health, it is important to review the prevalence of mental health problems on campus. It is doubly important to examine these phenomena as most disorders have a lifetime onset by the age of 24 and constitute almost half the disease burden of young adults (Kessler et al., 2005). One study with a large sample of over 4,000 students found that 41% met diagnostic criteria for psychopathology of some form, with 18% meeting criteria for a personality disorder, 12% for an anxiety disorder and 11% for a mood disorder (Blanco et al. 2008). Other data show similar rates with 37% of students reporting a mental health diagnosis within their lifetime and 16% reporting a diagnosis within the last 12 months (Lust & Golden, 2012). These rates are further supported by survey data from random samples at 26 different campuses where 17% of students met criteria for depression and 10% met criteria for an anxiety disorder (Eisenberg, Golberstein & Gollust 2007). Though it is hard to differentiate between increased help-seeking behavior and true increased rates of mental health disorder prevalence, it is notable that between 2007 and 2011, 88% of university counseling center directors reported an increase in the number of students seeking help for severe mental health disturbances and 87% of directors noted a

steep increase in the number of students seeking treatment who were already on psychoactive medications (NSCC, 2012). In sum, mental health problems frequently occur on campus and are possibly on the rise.

Help Seeking Behavior

Given the high prevalence of mental health disorders on campuses across the country and negative associations between stress and poorer mental health, it is important to examine the degree to which college students seek and receive treatment. Comparing college attending with non-college attending young adults, only 25% of individuals with a mental disorder sought treatment in the past year, regardless of status as a student (Blanco et al., 2008). In the ACHANCHA (2008) survey of nearly 100,000 college students, only 24% of students diagnosed with depression received treatment. Another sample looked at more than 2,000 college students and discovered that fewer than half of students diagnosed with depression or an anxiety disorder received treatment (Eisenberg et al., 2007). Additionally, of 30% of students who perceived a need for treatment, only 10% saw a counselor as a result.

Even when students wish to receive help, they are often unable to do so. Eisenberg et al. (2007) identified several explanations including, for some students, a lack of a perceived need for help, being unaware of services the university offered, and skepticism regarding treatment effectiveness. Demographically, students from lower socioeconomic backgrounds, men, religious students, international students and Asian American students were less likely to seek services for mental health problems than their peers (Eisenberg et al., 2009). It is evident, then, that a considerable number of students who would benefit from mental health services are not receiving the help they need.

Internet-Based Interventions

Technological progress has made internet-based interventions (IBI) a viable way to help those in need. Despite outreach efforts on campus, significant barriers to seeking mental health care still exist, including low-perceived need by students for help despite considerable symptoms of mental health distress, personal stigma, being unaware of services or insurance coverage, and skepticism about treatment effectiveness (Eisenberg et al., 2009; Eisenberg et al., 2007; Zivin, Eisenberg, Gollust & Golberstein, 2009).

Amstatder and colleagues (2011) argued that IBIs offer effective ways to address some of these barriers and provide additional advantages. First, IBIs are often free or inexpensive, certainly relative to face-to-face counseling. Second, they can be used in the privacy of one's own home, thus addressing concerns about stigma, privacy and access (e.g., you do not have to find childcare or transportation to use an IBI). Third, increasing use of the internet in the US has rendered IBIs a viable and feasible intervention medium. Given that fewer than half of college students with mood disorders and less than 20% of students with anxiety disorders receive treatment, often for the same barriers identified above, IBI's offer significant promise, especially as several studies show that between 90-97% of college students use the internet on a daily basis (Hunt & Eisenberg, 2010; Fortson, Scotti, Chen, Malone, & Del Ben, 2007). Additionally, support for electronic mental health services is high with 90% of students in one survey saying they would be willing to try an IBI (Klein & Cook, 2010). Finally, Richardson and Rothstein (2008) reviewed 33 different stress management programs and found that interventions of shorter duration were more effective than those lasting longer than four weeks ($d = .80$ vs. $d = .34$). Although the interventions reviewed were not administered over the internet,

they are notable for suggesting that shorter interventions are more effective and provide evidence as to the viability of shorter more discrete interventions such as IBIs in general.

Empirical Support for IBIs and the Treatment of Stress

A number of studies have examined Internet-based interventions for stress in college populations. One review examined 17 trials designed to reduce distress symptoms (Davies, Morriss, & Glazebrook, 2014). The majority ($n =$13) were administered over the web and nine were based on cognitive behavioral therapy. The authors found that, in comparison to inactive controls, these interventions reduced anxiety (pooled standardized mean difference [SMD] = -.56, $p<$.0001), depression (pooled SMD -.43, $p<$.001), and stress (pooled SMD -.73, $p = $.008). In comparison to active controls or a comparison intervention, sensitivity analyses did not support significant between-group differences among varying intervention conditions for either anxiety or depression. Five studies incorporated active controls that were psychoeducational in nature and generally provided descriptions of anxiety, prevalence rates, and available forms of treatment as well as general tips on how to manage stress. The authors noted several limitations of their meta-analysis. They reported that small sample sizes and skewed data may have biased their findings and recommended that future research include improved methodology including using study designs with adequate power and intent-to-treat analyses. They also suggested that future researchers work with students to find outcome measures that are relevant to their lives in addition to broad mental health indices (e.g., GPA). Additionally, the authors suggested future research examine other IBIs based on theories other than CBT theory as the majority they reviewed were based on CBT.

Farrer and colleagues (2013) conducted another review of 27 studies assessing technology-based mental health interventions for college students. The majority of the studies ($n = 24$) targeted anxiety and symptoms of stress and one third ($n = 7$) targeted both anxiety and depression. Overall, there were a total of 51 technology-based interventions delivered mainly via the computer ($n = 24$) and smartphone ($n = 5$). Results indicated that 24 out of 51 of the intervention conditions were associated with at least 1 significant positive outcome compared with the control at postintervention. Effect size calculations indicated that, for 18 of the 51 interventions that provided adequate data, the median effect size was .54 (range -.07 to 3.04) for the 8 interventions that targeted depression and anxiety symptoms and .84 (range -.07 to 2.66) for the 10 interventions that addressed anxiety symptoms. Limitations the authors noted included inadequate randomization procedures and most of the studies failing to conduct or report appropriate intent-to-treat analyses. The authors also reported that they could not complete analyses on follow-up scores because of the heterogeneity of the follow-up periods.

Other meta-analyses have demonstrated the effectiveness of IBI's as well, although not in college populations. Barak et al. (2008) examined 14 studies comparing IBIs with face-to-face therapy and found that they produced similar effects ($d=.39$ for IBIs vs. $d=.34$ for face to face). Additionally, there is some evidence that feedback in the form of email reminders increases participation which in turn increases efficacy. Still, further studies are required to determine if there is an optimal dose-effect relationship and thus an optimal amount of time needed to maximize the salutary effects of IBIs. For instance, some meta-analytic data have suggested that IBIs with fewer than 8 sessions were more effective than interventions with more than 8 sessions (within-group $d = .75$ vs

within-group $d = .39$; Richards & Richardson, 2012). Given the heterogeneity of the samples, interventions and assessment methods, further research is required to determine which interventions and samples require what number of sessions to optimize dose-effect. See Appendix C for more empirical evidence supporting the use of IBIs.

Mindfulness

The reviews of IBIs discussed above noted that the majority of IBIs were based on CBT theory (e.g. Barak et al., 2008; Davies, Morriss, & Glazebrook, 2014). Though CBT and various forms of behavioral interventions have successfully made the transition online, mindfulness IBIs are still in their infancy. The term 'mindfulness' refers to the ability to direct and sustain one's attention to the present moment in an accepting and nonjudgmental way (Kabat-Zinn, 1982). Referred to as the "observation of the ongoing stream of external and internal stimuli as they arise" (Baer, 2003, p. 126), mindful meditation is the purposeful focusing of attention on all stimuli accessible through the five senses. Internal stimuli include cognitions, emotions and behaviors whereas external stimuli include anything that can be seen, heard, smelled, tasted or touched (Kabat-Zinn, 1994). Sensory phenomena are observed carefully, curiously and without judgment (Marlatt & Kristeller, 1999). Thus, there are two components to mindfulness: self-regulation of attention and an orientation toward the present moment that is accepting and open. Acceptance in this formulation is not a passive or resigned surrender, but instead refers to one's ability to experience internal and external events "without resorting to either extreme of excessive preoccupation with, or suppression of, the [events]" (Keng, Smoski & Robins, 2011, p. 2). In fact, attention should be actively compassionate, curious, warm and kind, especially in the presence of aversive affect (Shapiro, Carlson,

Astin & Freedman, 2006). Experiencing the present moment with compassion and openness is believed to alleviate the effects of stressors because overly focusing on the past or future is often associated with feelings of depression and anxiety (Kabat-Zinn, 2003). It is thought that experiencing distressing situations contemplatively rather than reactively counters experiential avoidance strategies employed by those with psychological problems (Hayes, Luoma, Bond, Masuda, & Lillis, 2006). Indeed, several researchers believe these maladaptive avoidant strategies are responsible for the development and maintenance of the most common mood disorders (e.g., Bishop et al., 2004). See Appendix D for more information on mindfulness as well as empirical support for mindfulness interventions.

Mindfulness IBIs

Directly relevant to the purposes of the current study, three mindfulness-based online interventions have already been created and evaluated. Morledge et al. (2013) developed an 8-week internet-based stress management program incorporating many mindfulness elements. Participants (N=703) were randomized into one of three conditions: control, the mindfulness stress intervention, or the mindfulness stress intervention plus access to an online message board where participants could share their experiences using the intervention with one another.

Linear mixed modeling analyses indicated significant between-group differences in change from baseline scores for each of the intervention conditions compared with the control condition at the end of the program and at one month follow-up. The results for perceived stress and overall mental health were clinically meaningful according to two common clinically important difference (CID) criteria: change of more than 10% of the

score range and .50 baseline standard deviations within-group change. The sample had an initially high baseline stress score, probably because many were referred by physicians whose patients were struggling with stress, but on average the intervention groups were able to bring down stress levels to a normal range. Results were comparable to face-to-face mindfulness interventions (e.g., $d = .50$; Grossman et al., 2004) with participants who were similarly engaged for 6-8 weeks.

Another study (N=100) assessed the effectiveness and feasibility of an 8-week online mindfulness intervention based on MBSR and MBCT course content (Krusche, Cyhlarova, King, & Williams, 2012). The course taught participants how to use meditation and mindfulness skills via audio and video clips embedded in a website. Participants were also assigned homework logs to track how often they completed various mindfulness activities during the week. Weekly email reminders were sent to participants to encourage them to complete at least four weeks of content. Results indicated a large reduction in perceived stress from pre- to post-intervention (d=1.57) that was maintained at one month follow-up. The authors divided their sample into three groups according to the amount of practice reported by participants: high (every day), medium (sometimes) and low (rarely). Interestingly, there were no significant differences between these three groups, though participants in the high group had significantly higher baseline stress scores than the other groups. A significant limitation to the study was the lack of a control group. As such, reductions in perceived stress cannot be linked directly to the mindfulness intervention.

Perhaps the most relevant of the mindfulness-based IBIs reviewed, Cavanagh et al. (2013) evaluated via an RCT a two week, self-guided, online intervention designed to

reduce perceived stress and anxiety/depression symptoms within a university student population in comparison to a wait-list group. Results showed significant group by time interactions at post-test for perceived stress and symptoms of depression and anxiety. For perceived stress, simple contrasts showed that, whereas scores for the wait-list group remained unchanged, there was a significant decrease in perceived stress for the intervention group (within-group $d = .37$). Similarly, there was a significant group by time interaction for anxiety and depression symptoms. Simple contrasts showed that scores on the wait-list group remained unchanged while there was a significant decrease in anxiety and depression symptoms for the intervention group (within-group $d = .24$). See Appendix E for more information on the effectiveness of mindfulness IBIs.

To summarize, there is substantial and growing evidence that mindfulness interventions are effective for addressing a host of psychological problems. Moreover, there is evidence that mindfulness interventions can be effectively delivered online. Nonetheless, Keng, Smoski and Robins (2011) contended that there are still many questions. Given the variety in treatment modes (e.g., some feature meditation, others exercises and skills training through homework) it is unclear which aspects of the programs are essential for promoting positive change. It is also, at this time, unclear what the optimal level of treatment is required to be effective. Carmody and Baer (2009), for instance, did not find a dose-effect relationship between time spent meditating and effect size in their review of 30 different studies. Similarly, Vettese and colleagues (2009) found no relationship between amount of mindful meditation and positive outcome. As such, research should attempt to identify mediators that might account for positive change.

Summary and Limitations of Existing Research

       Summary. Stress is clearly associated with a number of negative physical and mental health outcomes. Stress can impact the functioning of the immune system and promote deleterious behaviors such as smoking and drug use. Stress is also associated with anxiety and depression and is negatively associated with life satisfaction as well.

       Many college students report high levels of both academic and interpersonal stress. As a consequence, college students experience a range of poor outcomes that are often exacerbated by lack of health-seeking behavior. This lack of mental health service utilization on campus is due to a number of factors including lack of perceived need, stigma, and the belief that psychological interventions are unlikely to be successful.

       Nevertheless, several interventions have been developed to address the effects of stress. Overall, many of the most effective stress interventions teach CBT or relaxation, and are usually brief. Some interventions for stress and mild to moderate mood disorders have been successfully adapted to the internet for widespread use to address unmet needs and to provide participants with a empirically supported treatment that can be self-administered in the privacy of one's own home at little or no cost. But CBT and relaxation skills are not the only ways to address stress. In fact, there is also growing evidence that mindfulness interventions are an effective way to deal with stress and concomitant anxiety. There is some evidence that mindfulness interventions increase behavioral and cognitive flexibility and habituate users to aversive internal emotional experiences which in turn reduces maladaptive coping strategies and improves emotion regulation.

There is, moreover, preliminary evidence that mindfulness meditation interventions can be successfully adapted for use on the internet. It stands to reason that if a brief IBI using mindfulness principles can decrease rumination and improve emotion regulation skills, then users would experience a reduction in stress and anxiety. Given that the internet is widely used by students on campus, it is likely that IBIs might address some of the problems with help-seeking behavior among college students listed above.

Limitations. Although the literature provides considerable data on negative outcomes associated with stress as well as the prevalence of stress in college populations, several questions have yet to be resolved regarding how best to intervene with students.

First, there are few interventions designed to help students experiencing general stress (as opposed to exam stress), but there are even fewer IBIs to address student stress. Additionally, some of them require face-to-face contact, thus reducing ease of access. Even for the few online stress management programs, many of the studies evaluating their efficacy suffer from poor design, are underpowered, lack control comparison groups and lack adequate follow-up assessment. There is a clear need for feasible, accessible, well-designed and evaluated interventions to help a general college population who, for various reasons, do not engage in adequate help-seeking behavior.

Second, although there is evidence that CBT can be successfully adapted for online use, the data on whether mindfulness interventions can be likewise utilized remains tentative and nascent. It is not currently well-established whether mindfulness IBIs could likewise be adapted for use on the internet. For the few examples of mindfulness IBIs reviewed above, many questions remain. For example, it is unclear

whether students can use meditation, a fundamentally relaxing and focused practice, on a platform that is rife with distractions.

Third, the literature on mindfulness interventions, whether online or delivered face-to-face, is uncertain regarding mechanisms of change in mindfulness interventions There is some evidence that it could improve self-compassion, attention, non-reactivity (via exposure), emotion regulation skills and also cognitive and behavioral flexibility. However, this evidence is preliminary and has not been adequately assessed or replicated. There is a need to determine the reason mindfulness interventions work to optimize their effectiveness.

In conclusion, there is a need for discreet, effective interventions to help college students manage stress. Can a mindfulness IBI, evaluated via a rigorous study and appropriately analyzed, offer relief to students suffering from stress and anxiety and other negative psychological outcome? If so, can we determine how and why it is effective?

A Mindfulness Internet-Based Intervention for College Stress

To prepare for this study, a pilot intervention was developed and evaluated in two studies and compared to two different intervention conditions. The results of each are described below.

First pilot intervention. The initial mindfulness intervention served as a comparison group for a study further evaluating the effectiveness of an online intervention for college stress based on present-control research (Hintz, Frazier, & Meredith, 2014). The initial present control intervention, and the first study assessing its efficacy, will be described first, followed by the study in which the present control intervention was compared to the first iteration of a mindfulness intervention.

The present control intervention (PCI) provided psychoeducational videos and written exercises (called stress logs) designed to help students increase their sense of control over self-identified stressors. Prior research identified the construct of present control, defined as the belief that one has some agency over current aspects of stressors, as being associated with lower general distress, event-specific distress, binge drinking, risk of PTSD and better adjustment (Frazier et al., 2011). One goal of this research was to develop an intervention that could increase one's sense of present control in the hopes that doing so would reduce negative outcome associated with low levels of present control.

The intervention consisted of four modules and was created using Google sites. Each module contained a video of an expert (a tenured professor at the university where the research was conducted) who provided education about the specific topic of the module (e.g., stress and present control), a narrated presentation (created using Prezi) that highlighted the experiences of past intervention participants as they related to the module topic, and an application exercise.

Results from analyses evaluating the initial PCI compared to a psychoeducational comparison group in a sample of 233 Introductory Psychology students indicated that the present control intervention group reported significantly less perceived stress, anxiety and depression than the stress-information only group at post-intervention, with between-group effect sizes ranging from $d = .19$ (stress) to .39 (depression), and an average effect size of $d = .32$ (Hintz et al., 2014). At 3-week follow-up, between group effect sizes were d's $= .14$ to .43 (average $d = .31$) on relevant psychological outcomes.

Results from this study indicated the PCI was effective at reducing symptoms related to anxiety, stress and depression. However, because there was no comparison group other than the stress-information control, a mindfulness IBI was developed to see how the PCI would fare vis a vis an intervention with different theoretical underpinnings. That study is reviewed below.

Participants for this study were recruited from an introductory psychology course at a large Midwestern university; the study took place over the course of a standard 16-week semester. There were no inclusion criteria other than membership in an introduction to psychology course at the university. Students ($N = 512$) were randomized to the standard PCI ($n=335$) condition (designated group 1A) or wait-list condition ($n=172$; designated group 1B). The students were randomized in a 2 to 1 ratio to the intervention group. Across the two groups, 441 students (86%) finished both the pretest and posttest with 71 students lost to attrition. There were no significant differences between the groups at baseline.

Sign-up for the study took place online and all instructions to participants were delivered via email. During week 1 of the study, all participants completed the pre-test measures online and were randomized either to the standard present control intervention (1A) or the wait-list control group (1B). Participants in the wait-list control group (1B) were told they could begin the intervention after spring break in week 10. As group 1A did not include the mindfulness intervention, it will not be described here although the group that received the PCI (1A) did report lower stress symptoms and perceived stress than the wait-list group (1B), providing further evidence for the effectiveness of the perceived control intervention.

At week 10, students in the wait-list group (1B) were randomized to one of three conditions: another present-control intervention similar to the one described above (Hintz et al., 2014) (1B-PCI; n=36), a condition where the steps involved in determining what action to take over controllable stressors were much more involved and elaborate using 'enhanced stress logs' (1B-PC+ESL; n=35), and a group that received a mindfulness IBI (1B-PC+MF; n=37). Both of these new interventions were developed to increase the efficacy of the original PCI intervention. A second cohort of students (N = 200) assigned to the exact same conditions described above (2-PCI, n=65; 2-PC+ESL, n=69; 2-PC+MF, n=66) also began the study at this time as Cohort 1B. For the purposes of brevity, the results of both groups (1B and 2; N=308) will be evaluated together.

All groups completed each of the four psychoeducational modules related to the PCI which were posted to the website every four days. All groups completed one practice stress log each during modules 1, 2 and 3. Group 1B-SL then completed 3 stress logs over the next two weeks. Group 1B-PC+ESL and 1B-PC+MF diverged from 1B-PCI here. 1B-PC+ESL completed three activities involving identifying and prioritizing stressors and well as how to change stressors. Participants randomized to the mindfulness intervention watched a short psychoeducational video on the rationale behind mindfulness interventions. Then, over the course of the next 4 weeks, they were asked to listen to a brief guided meditation audio file posted to the intervention website once per week. This meditation focused on helping students mindfully attend to their breath, physical sensations, thoughts and feelings. After completing each guided meditation, participants were asked to complete a short online written log describing how their

relationship to their stressor had changed. At the end of the study, subjects completed an online post-test.

Participants in both cohorts were assessed with several different outcome measures including the positive and negative affect; perceived stress; depression, anxiety, and stress symptoms; and worry. Measures of three potential mediators – present control, non-reactivity, and rumination – were also completed. All measures were completed pre- and post-intervention. ANCOVAs were conducted, controlling for baseline scores on the outcome measures, testing for the following main and interactive effects on 10 post-intervention scores: cohort (1B vs. 2), condition (PCI, PC+ESL, vs. PC+MF), and cohort X condition. There were no significant cohort X condition interactions which indicated that the two cohorts did not respond differently to the two interventions and thus could be combined. However, there were significant cohort effects on two measures, such that Cohort 1B scored lower on stress symptoms and positive affect than Cohort 2. There was only one significant condition effect on present control. Follow-up tests revealed that those in the PC+MF condition reported more present control than those in the PC+ESL condition.

Although the three groups did not significantly differ in effectiveness, it is instructive to examine the within-group differences. Overall, the PC+MF group had an average effect size of $d = .31$ on outcome measures assessed (depression, anxiety, stress, perceived stress, positive affect, negative affect and worry) compared to the PCI group's average effect size of $d = .07$ and the PC+ESL group's average effect size of $d = .33$. The results found in the PC+MF condition were consistent with the medium-sized effects in other mindfulness IBIs and IBIs in general (Barak et al., 2008; Cavanaugh et al., 2013).

Although there were no significant differences between treatments, this is likely due to

the study being underpowered to detect what were likely to be small differences among

the three active treatment groups. However, the pattern suggests that the combination of

mindfulness and present control was more effective than present control alone.

Because no participants received the mindfulness intervention without also having

watched the four psychoeducation modules concerning present control and completing

stress logs, it is difficult to evaluate the overall impact of the mindfulness IBI per se. Still,

as preliminary data, there is some indication that the mindfulness IBI was effective. See

Appendix F for pilot study within and between-group effect size tables.

Second pilot intervention. The same three interventions were evaluated in a

second pilot study conducted at a community college in the upper Midwest. The study

took place over the course of a standard 16-week semester. There were no inclusion or

exclusion criteria. Students who expressed interest in participating ($N = 213$) were

randomly assigned to either the standard PCI (n = 70), the PCI + enhanced stress log

intervention (n = 70) or the PCI + mindfulness intervention (n = 73). In the total sample,

68% completed the posttest (n = 144).

ANCOVA analyses were conducted with time 1 scores as covariates comparing

the three conditions on follow-up scores on outcome measures assessing anxiety, stress,

depression, and perceived stress and measures of two mediators (present control and

rumination). None of the six condition effects were significant. Between group effect

sizes (*d*) ranged from .01 to .38 with the largest differences occurring between the PCI

and Mindfulness groups on depression (between group $d = .38$) and rumination (between

group $d = .37$). In these two cases, the PCI group had larger within group effect sizes than

the Mindfulness group. Overall, the mindfulness treatment group had an average within-group effect size of $d = .47$ on outcome measures assessed (depression, anxiety, stress, and perceived stress) compared to the PCI group's average effect size of $d = .38$ and the PCI+ESL group's average effect size of $d = .51$.

Thus, in both pilot studies the PC + mindfulness intervention was somewhat more effective than the original present control intervention and about as effective as the original intervention with enhanced stress logs. In both studies, the within group effect sizes for the PCI + mindfulness conditions were small to moderate. See Appendix F for pilot study within and between-group effect size tables.

Purpose of the Dissertation Study

The purpose of this study was to investigate the efficacy of a 4-week long mindfulness-based Internet delivered intervention compared to the previously-assessed intervention that combines present control and mindfulness and an active comparison group. Efficacy was assessed using several measures of distress completed at preintervention, postintervention, 1st follow-up and 2nd follow-up. Three potential mechanisms of intervention efficacy also were assessed at preintervention, midintervention, postintervention, 1st follow-up and 2nd follow-up: present control, rumination, and mindfulness. Analyses assessed both within and between group differences. Mediational analyses were conducted to determine the validity of purported mechanisms of change. Qualitative comments were gathered from students regarding their experience of the interventions for the purpose of continuing refinement of the interventions.

This study contributes to the existing stress literature in many ways.

1. Further demonstrates viability of a stand-alone online mindfulness intervention aimed at stress

2. Evaluates mechanisms of change for which little analysis in current literature exists

3. Experimental design includes a comparison group to evaluate relative efficacy of mindfulness intervention vis a vis a mindfulness + present control intervention that has already been evaluated.

4. Psychoeducational control condition will also provide means of evaluating whether the two intervention conditions are more effective than general stress management information.

5. Contributes to literature on effectiveness of online interventions.

Hypotheses

Outcome Hypotheses

1. Both intervention groups (i.e., mindfulness + present control and mindfulness only) will have lower levels of distress on all outcome measures than the comparison group at post-intervention and at both follow-ups. The intervention groups were not expected to differ significantly from each other.

2. Both intervention groups (i.e., mindfulness + present control and mindfulness only) will report more mindfulness, less rumination, and more present control (i.e., the three mediators) than the comparison group post-intervention and at both follow-ups.

3. The mindfulness + present control group will have higher levels of present control than either the mindfulness or comparison group post-intervention and at both follow-ups.

Mediation Hypotheses

1. The following variables will be significant mediators of the greater effectiveness of the mindfulness + present control group relative to the comparison group in reducing distress: increases in present control and mindfulness and decreases in rumination

2. The following variables will be significant mediators of the greater effectiveness of the mindfulness only group relative to the comparison group in reducing distress: increases in mindfulness and decreases in rumination.

Method

Participants and Procedures

Participants were students at a large Midwestern university who received extra credit for their participation. The students were recruited in two separate waves that began two weeks apart to maximize recruitment. Experimental conditions in the two waves were identical. Both waves were grouped together for analyses. The only inclusion criterion other than the requirement that participants be enrolled in a psychology course at the participating university was that students expressed an interest in learning stress management skills. There were no exclusion criteria. In total across both waves students ($N = 401$) who expressed interest in participating were sent a link to the study web site containing the consent form and pretest survey. Of those, 90% ($n = 365$) consented and completed the pretest. The students were then randomized using Excel's random number

generator to the mindfulness plus present control condition ($n = 121$), mindfulness

condition ($n = 122$), or the psychoeducational comparison group ($n = 122$). Those who

completed the pretest comprised the intent-to-treat sample. An a priori power analysis

using G*Power 3.17 (Faul, Erdfelder, Buchner, & Lang, 2009) indicated that 269

participants ($N = 90$ per condition) would be necessary to detect a medium effect in an

ANCOVA with three groups and one covariate at a significance level of .05 and power of

.80. Thus, the study is powered to detect differences between the intervention groups and

the comparison groups but not between the two intervention groups. The University of

Minnesota Institutional Review Board approved the protocol for this study.

The demographics of the sample follow. Most of the participants were female

(75%) and between the ages of 18-21 (74%). Racially, the sample was mostly white

(73%), Asian (17%) or Hispanic (3%) and in their junior year of college (33%). There

were no significant differences among the treatment conditions with respect to gender,

age, race, or year in school. Information about study attrition can be found in Figure 1.

Intervention

The study was a randomized controlled trial with three conditions: mindfulness as

an adjunct to an online present control intervention, a mindfulness intervention, and a

psychoeducational stress management control comparison group. All three interventions

were delivered over the Internet using the participating university's Moodle course

management system. The intervention was administered over the course of four weeks,

although the first wave of participants was given an extra week to complete the

interventions because spring break interfered with participation. Participants received an

email when it was time to review video modules or complete logs and also received a reminder email to complete activities at the end of each week.

Surveys to assess intervention efficacy were completed pre-test, post-test, at a 2- or 3-week follow-up and at a 4- or 5-week follow-up. Differences in the timing of follow-up assessments were due to survey completion deadlines being extended to maximize participation. For clarity, follow-ups from now on will be referred to as first and second follow-up. Some variables theorized to be mediators were also assessed two weeks into the intervention in addition to all other time points. The first wave of the study began four weeks after the spring semester began and the final follow-up survey was administered during the last week of classes. The second wave began the study six weeks after the spring semester began and the final follow-up was also administered during the last week of classes.

Mindfulness + present control internet-based intervention (IBI). During the first week, participants in this condition watched three psychoeducational modules related to the concepts of present control and stress. Module 1 contained information about common college student stressors and outcomes; Module 2 defined past, present, and future control and described the positive outcomes associated with present control; and Module 3 described how to avoid pitfalls in implementing present control. A series of motivational interviewing questions (e.g., How confident are you that you can improve at handling stress?) also were added to the module exercises which were intended to reduce attrition and build motivation for continuing the intervention. After module 2 students were asked to complete one stress log where they identified stressors that were controllable and those that were not. Students were also asked to indicate what action

they could take to reduce stress associated with self-identified controllable stressors. In the second week, participants watched a brief psychoeducational video on the principles of mindfulness. They then listened to a meditation and completed one short mindfulness log. In weeks 3 and 4 participants listened to the same meditation and completed a short mindfulness log twice per week.

Mindfulness IBI. This condition was a stand-alone mindfulness intervention. In this condition participants first watched the same mindfulness psychoeducational video described in the mindfulness + present control intervention above. During the first week, participants also listened to a downloadable guided meditation focusing on the breath and filled out a short mindfulness log where they briefly described their experience and reported any difficulties encountered. During the second week, participants listened to a meditation focused on noticing and attending to physical sensations, including the breath, twice and completed one mindfulness log. In the third week, participants were asked to complete two weekly sessions of a third guided meditation that focused on attending nonjudgmentally to thoughts and feelings that arose during practice. They also completed two mindfulness logs, one after each meditation. Finally, in the fourth and last week participants listened to a meditation that focused on all cognitions and sensations twice. They again completed two mindfulness logs, one after each meditation. The meditation used in week four was the one participants listened to in the Mindfulness + Present Control intervention.

Differences in the number of stress logs completed between the Mindfulness + Present Control and the Mindfulness group were due to efforts to minimize participant attentional and self-report burden. In weeks where there was a psychoeducational

component or an additional assessment to the intervention (e.g., midintervention, week 2)

participants were only asked to fill out a single stress log. Additionally, the types of

meditations listened to varied between the Mindfulness + Present Control and

Mindfulness groups to see if there were any advantages to learning mindful meditation

techniques together (Mindfulness + Present Control) or separately (Mindfulness only

group).

      Stress management comparison group. This group provided a

psychoeducational comparison group for the mindfulness and mindfulness + present

control intervention groups. Participants were directed to a website

(http://www.sass.umn.edu/fivefactors/selfhelpmaterials.html) provided to students by the

participating university's counseling services. Each week, participants were sent links to

different psychoeducational sheets to read covering various ways to manage stress. As

with the intervention groups above, participants were emailed when various components

were added to the website. Participants were also asked to verify that they spent at least 5

minutes per week reviewing the stress management tips. Links to each of the

psychoeducational sheets sent to participants in the comparison group are in Appendix G.

Measures

      Measures were completed in the following order by participants: present control,

stress, depression and anxiety symptoms, perceived stress, worry, mindfulness, and

rumination.

      Stress, depression and anxiety symptoms. Depression Anxiety and Stress

Scales (DASS-21; Lovibond & Lovibond, 1995) is a 21-item measure containing three 7-

item scales assessing depression, anxiety, and stress (e.g. "I found it hard to wind down")

over the past week. Each item is rated on a 0 (*does not apply*) to 3 (*very much*) scale. In past research with college student samples, the alpha coefficients for scores on the DASS subscales ranged from .81 to .87 (Frazier et al., 2009). The validity of DASS-21 scores has been established by substantial correlations of each subscale with similar constructs (Crawford & Hendry, 2003). Cronbach's alpha for the current sample ranged from .92 to .94 across four time points.

Perceived stress. Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermelstein, 1983) has 10 items that measure the perception of stress (e.g. "How often have you felt nervous or 'stressed?') over the past week. Participants rated items on a scale from 0 (*Never*) to 4 (*Very Often*). Reliability and validity of scores in similar populations has been established (e.g., alphas from .84 to .85; Cohen et al., 1983). Cronbach's alpha for the current sample ranged from .83 to .84 across four time points.

Worry. The Student Worry Questionnaire-30 (SWQ; Osman et al., 2001) is a 30-item measure of six domains of worrisome thinking including concerns about finances, significant others' well-being, social adequacy, academics, and general anxiety symptoms over the past week. Participants rated each statement (e.g., "I worry about getting bad grades in my courses") on a 5-point scale (0 = *almost never characteristic of me* and 4 = *almost always characteristic of me*). The total scores showed internal consistency ranging from .80 to .94 and test-retest reliability coefficients of .75 to .80 (Osman et al., 2001). Evidence of convergent validity also was reported. In the current study, only the academic concerns and general anxiety symptoms subscales were used because those types of worries were deemed most germane to the current study. Cronbach's alpha for the current sample ranged from .88 to .91 across four time points.

Mindfulness. Five-Facet Mindfulness Questionnaire (FFMQ; Baer, Smith,

Hopkins, Krietemeyer, & Toney, 2006), is a 39-item inventory assessing multiple facets

of mindfulness over the past week. Scores derived from the FFMQ have been shown to

have strong psychometric characteristics, including adequate to good internal

consistencies for all facets and significant correlations in predicted directions with other

related constructs (Baer et al., 2006). The FFMQ assesses five facets of mindfulness

(observing or noticing experience; acting with attentional awareness or avoiding

automatic pilot; non-reactivity to internal experience; describing or labeling feelings;

nonjudging of experience). Item responses are made on a scale ranging from 1 = *"never*

or very rarely true" to 5 = *"very often or always true"* and evaluate statements such as "I

criticize myself for having irrational or inappropriate emotions." For the purposes of this

study, the 8-item Observe subscale was removed because confirmatory factor analysis

revealed four factors as having better model fit for inexperienced meditators (Williams,

Dalgleish, Karl & Kuyken, 2012). All other subscales were combined to test score

reliability. Cronbach's alpha for the current sample ranged from .90 to .93 across five

time points.

Present control. The Perceived Control over Stressful Events Scale (PCOSES;

Frazier et al., 2011) is a 22-item measure designed to assess perceptions of past, present,

and future control over specific stressors over the past week. Only the present control

subscale was used in the analyses. Individuals rated the eight present control items (e.g.,

"I have control over how I think about the situation") on a 4-point scale (1 = *strongly*

disagree to 4 = *strongly agree*). In previous research with undergraduate samples, alpha

coefficients for present control scale scores ranged from .77 to .86 and 3-week test-retest

reliability was .59; convergent and discriminant validity were demonstrated via correlations in expected directions with other measures (Frazier et al., 2011; Frazier et al., 2012). Cronbach's alpha for the current sample ranged from .84 to 88 across five assessment periods.

Rumination. Rumination was assessed using the Ruminative Thought Style Questionnaire (RTS; Brinker & Dozois, 2009). To reduce participant burden, four items were chosen from the 20-item RTS based on reliability analyses using data from prior studies at Normandale Community College and the University of Minnesota. The items were chosen because they had the highest item total correlations in both samples. Items were rated on a 1 (*strongly disagree*) to 7 (*strongly agree*) scale (e.g., "When I am anticipating an interaction, I will imagine every possible scenario and conversation"). Participants were asked about their experiences with rumination over the past week. Brinker and Dozois reported evidence for the reliability and validity of RTS scores. Cronbach's alpha for the current study ranged from .90 to .92 across five time points.

Participant feedback. During the postintervention assessment, students were asked to evaluate, in both quantitative and qualitative terms, the extent to which the three interventions were helpful, to offer thoughts on why they believed the intervention was helpful, and to state how likely they were to keep using the intervention now that the study had concluded. This information was collected to refine the intervention in future iterations.

The first question asked, "Do you plan on continuing additional exercises, similar to the ones you already completed, now that the study is over?" and was answered on a 1 (never) to 5 (very often) scale. Other questions included, "If you found the program

helpful, please explain why it was helpful to you" and "If you have any suggestions for improving the program, please describe them". Students were also asked "Would you have completed the online stress program if you weren't getting extra credit for it?" and given the answer options "Yes, No, Maybe and Other". Additionally, students were asked, "Would this program be improved if you received personalized messages regarding your logs?" and "If yes to the above, what kind of personal feedback would you have preferred?" and given the answer options "Personalized reminders to meet various study deadlines, Supportive encouragement, and Tips on stress management". Finally, students were asked "If we were to send you feedback or personalized messages, how would you like to receive them?" and were given the options, "Text Messages, Email Messages, Phone calls, I wouldn't want to receive additional messages from this study and Other"

Data Analysis Strategy

Linear mixed models were used to assess intervention effects using an intent-to-treat approach. Linear mixed effects were assessed in SAS. Mixed models are superior to ANCOVA because they can accommodate missing data points and participants do not need to have the same number of observations. Further, unlike ANCOVA, mixed models can address data that are correlated by accounting for different variance-covariance structures. In the final models, missing data were estimated using restricted maximum likelihood estimation. Analyses included fixed effects for time (pretest, posttest and two follow-ups for outcomes and pretest, midintervention, posttest and two follow-ups for mediators), the three intervention groups, the time by intervention group interactions, and random intercepts by participant (to reflect differences between participants at pretest).

Significant time by intervention group interactions indicate meaningful between-group differences in change over time (i.e., pretest to posttest and pretest to follow-ups). Within-group contrast estimates reflect the amount of change over time on outcomes within groups. Within-group effect sizes were calculated by subtracting the mean of each group at mid-test (for mediators), post-test, and the two follow ups from the mean of that group at pretest and dividing by the standard deviation (SD) of that group at pretest as recommended by Morris and DeShon (2002). The between-group difference is the difference between the within-group effect sizes for two groups. The time by intervention group interactions are reported in the text, the within-group contrast estimates are in Tables 4 and 5, and the within- and between-group effect sizes are in Tables 6-9.

Hierarchical regression was used to assess mediation. For all mediator variables, change scores were calculated to reflect change over time from preintervention to final follow-up. Outcome measures were from the final follow-up and preintervention scores on each outcome were entered into the first step of the regression model so that the model would control for outcome scores at preintervention. In the second step, the change scores for the three mediators were entered. Consequently, the hierarchical regression showed the relationship between change in mediators over time and outcome variables of interest controlling for preintervention outcome scores. Multiple imputation was used to account for missing data prior to conducting regression analysis. The results of the regressions using five imputed data sets were pooled and standardized beta coefficients reported.

Results

Preliminary Analyses

At posttest, 110 participants (30%) had dropped out of the study: $ns = 45$ (PC +

MF), 41 (MF), and 24 (comparison group). By the first follow up 100 individuals (27%)

had discontinued participation: $ns = 40$ (MF+PC), 37 (MF) and 23 (comparison group).

By the second follow up 127 students (34%) had discontinued participation: $ns = 47$

(MF+PC), 47 (MF), 33 (comparison group). Overall, 238 (65%) completed measures at

the second follow up: 74 (61%) of the MF + PC, 75 (61%) of the MF and 89 (73%) of the

comparison groups. The number of participants at 1st follow-up increased somewhat as

students were allowed to continue in the study even if they neglected to complete surveys

at post-test. There were no significant differences at baseline on demographic, mediator

or outcome variables for those who completed surveys at the second follow up versus

those who did not. Complete information about participant attrition is reported in Figure

1.

To improve data quality, careless responders were identified and removed.

Careless responders are participants who answer survey questions inattentively or

randomly and who, in substantial numbers, can increase the chance of a type II error in

hypothesis testing (Mead & Craig, 2012). Following Mead and Craig's

recommendations, the current study asked respondents at the conclusion of the post-

intervention survey, "In your honest opinion, should we use your data?" Forty-one

participants said we should not and their data was removed from the study. The current

study also included 2-3 instructed response items to account for careless responders in

each of the surveys administered. If participants missed more than two instructed

response questions across all the surveys they were identified as careless responders and removed ($n = 4$). In total, 45 participants (12% of the sample) were removed for either being random or inattentive responders. This rate is consistent with other student samples (Mead & Craig, 2012). There were no significant differences between groups in the number of students who said not to use their data.

All variables were examined for outliers at all time points. Grubb's test for outliers detected a single outlier on the DASS Anxiety subtest at both follow ups. Upon visual inspection, the data points did not appear to be outliers so the individual's scores were kept in the analyses. Table 1 and Table 2 show the means and standard deviations for mediator and outcome variables respectively. Table 3 shows the correlations between measures at preintervention.

Intervention Effects on Mediator Variables

Linear mixed models (LMM) were run to assess whether the two interventions resulted in greater increases in present control and mindfulness and greater decreases in rumination relative to the comparison group (see Table 4 for results of LMM analyses). Table 6 contains the within-group effect sizes and Table 7 contains the between group effect sizes.

Present control. The time by intervention group interaction effect was not significant, indicating that there were no between-group differences in change in present control over time $F(8, 988) = .16$, $p = .99$. Present control increased significantly from pretest to midintervention, postintervention and both follow-ups in all three conditions (see Table 4 for contrast coefficients). The within-group effect sizes (Table 6) indicated that the increases were small to moderate in all three groups and for all time comparisons

(within group d's = .25 to .38). At the second follow-up (4-5 weeks postintervention), the within-group effect sizes reflecting change from pretest to follow-up ranged from .25 to .38. All between-group effect sizes were small (d's = .00 to .13; see Table 7). See Figure 2 for intervention effects on present control.

      Mindfulness. There was also no significant time by intervention group interaction effect for mindfulness (i.e., no between-group differences in change over time, $F(8, 991)$ = .83, p = .57). Mindfulness did not significantly increase from pretest to midintervention for any condition nor did it increase in the Mindfulness only condition pretest to posttest. All other increases in mindfulness were significant at all other time points (see Table 4 for contrast coefficients). The within-group effect sizes (Table 6) indicated there were small to large increases in mindfulness in all three groups from pretest to posttest and both follow-ups (within group d's = .15 to .71). At the second follow-up (4-5 weeks postintervention), the within-group effect sizes reflecting change from pretest to follow up ranged from. 42 to .71, with the biggest change in the Present Control + Mindfulness condition. All between group effect sizes were small (d's = .08 to .29; see Table 7). The biggest difference was between the Mindfulness + Present Control and Mindfulness conditions (between-group d = .29), with more change in mindfulness in the Present Control + Mindfulness condition than in the Mindfulness condition. See Figure 3 for intervention effects on mindfulness.

      Rumination. There was a significant time by intervention group interaction effect indicating there were between-group differences in rumination, $F(8, 973)$ = 3.73, p = .0003. The significant difference was between the Mindfulness + Present Control and comparison conditions (between-group d = .52) at postintervention with more change

evident in the Mindfulness + Present Control condition than in the comparison condition, $t (973) = -2.70$, $p = .007$. Rumination did not significantly decrease from pretest to midintervention for any condition nor did it decrease in the comparison condition pretest to posttest. All other decreases in rumination were significant at all other time points (see Table 4 contrast coefficients). The within-group effect sizes (Table 6) indicated that there were medium to large decreases in rumination in all three groups. These decreases began for the Mindfulness + Present Control group and Mindfulness only groups at postintervention and continued through to the second follow-up. Decreases did not begin for the comparison group until the first follow-up but continued to the second follow-up (within group d's = -.37 to -.62). At the second follow-up (4-5 weeks postintervention), the within-group effect sizes reflecting change from pretest to follow-up ranged from -.37 to -.45 with the largest changes in both the Mindfulness + Present Control and Mindfulness only conditions. Between-group effect sizes were small to large (d's = .00 to .52; see Table 7) with the largest differences occurring at postintervention (d's = .24 to .52). The largest between-group difference occurred between the Mindfulness + Present Control condition versus the comparison group favoring the Mindfulness + Present Control group ($d = .52$). The Mindfulness only group was also superior to the comparison group ($d = .28$). The smallest between group differences occurred at the midintervention assessment with between-group effect sizes ranging from 0 to .05. See figure 4 for intervention effects on rumination.

Intervention Effects on Outcome Variables

To test if the PCI + mindfulness and the mindfulness interventions reduced levels of stress, anxiety, depression, perceived stress and worry more than the comparison

group, intervention effects were estimated using linear mixed models (LMM). See Table 5 for contrast coefficients, Table 8 for within group effect sizes, and Table 9 for between group effect sizes.

Stress symptoms. The time by intervention group interaction effect was not significant indicating that there were no between-group differences in change from pretest to posttest or either follow-up, $F(6, 737) = .50$, $p = .81$ Stress decreased significantly from pretest to midintervention, postintervention and both followups in all three conditions with the exception of the Mindfulness only condition from pretest to 2nd follow-up (see Table 5 for contrast coefficients). The within-group effect sizes (Table 8) indicated that there were small to moderate decreases in stress in all three groups and for all time comparisons (within group d's $= -.19$ to $-.45$). At the second follow-up (4-5 weeks postintervention), the within-group effect sizes reflecting change from pretest to follow-up ranged from $-.19$ to $-.45$ with the largest reduction in stress occurring in the Present Control + Mindfulness condition. All between-group effect sizes were small (d's $= -.03$ to $.26$; see Table 9). The biggest difference was between the Mindfulness + Present Control condition and the Mindfulness only condition with the Mindfulness + Present Control group reducing stress more than the Mindfulness only group (between-group $d = .26$). See Figure 5 for intervention effects on stress.

Anxiety. There was no significant time by intervention group interaction effect for anxiety, $F(6, 737) = 1.08$, $p = .37$. There were significant decreases in anxiety for all conditions and time points with the exception of the Mindfulness only condition from pretest to both follow-ups (see Table 5 for contrast coefficients). The within-group effect sizes (Table 8) indicated that there were small to moderate decreases in anxiety in all

three groups and for all time comparisons (within group d's = -.15 to -.42). At the second follow-up (4-5 weeks postintervention), the within-group effect sizes reflecting change from pretest to follow-up ranged from -.18 to -.42 with the Mindfulness + Present Control condition indicating the most change. All between-group effect sizes were small (d's = .04 to .23; see Table 9). The biggest difference was between the Mindfulness + Present Control and Mindfulness only conditions (between-group d = .23) with the Mindfulness + Present Control group reducing anxiety more than the Mindfulness only condition at both follow-ups. See Figure 6 for intervention effects on anxiety.

Depression. The time by intervention group interaction effect was not significant indicating that there were no between-group differences across conditions in change from pretest to posttest or either follow-up, $F(6, 737) = .22$, $p = .97$. There were significant decreases in depression in all conditions at all time points with the exception of the Mindfulness only group from pretest to 2nd follow-up (see Table 5 for contrast coefficients).The within-group effect sizes (Table 8) indicated that there were small to moderate decreases in depression in all three groups and for all time comparisons (within group d's = -.19 to -.33). At the second follow-up (4-5 weeks postintervention), the within-group effect sizes reflecting change from pretest to follow-up ranged from -.19 to -.32. The MF + PC and comparison groups reduced depression scores the most (ds = -.31 and -.32, respectively). All between-group effect sizes were small (d's = .01 to .14; see Table 9). See Figure 7 for intervention effects on depression.

Perceived stress. There was no significant time by intervention group interaction effect for perceived stress, indicating that there were no between-group differences in change from pretest to posttest or either follow-up, $F(6, 689) = .36$, $p = .90$. Perceived

stress decreased significantly from pretest to postintervention and both followups in all three conditions (see Table 5 for contrast coefficients). The within-group effect sizes (Table 8) indicated that there were small to moderate decreases in perceived stress in all three groups and for all time comparisons (within group d's = -.34 to -.56). At the second follow-up (4-5 weeks postintervention), the within-group effect sizes reflecting change from pretest to follow-up ranged from -.34 to -.55 with the largest within-group change occurring in the Mindfulness only condition. All between-group effect sizes were small (d's = .02 to .21; see Table 9). The biggest difference was between the Mindfulness only and the comparison group (between-group d = .21) with the Mindfulness only condition reducing perceived stress more than the comparison group. See Figure 8 for intervention effects on perceived stress.

Worry. The time by intervention group interaction effect also was not significant for worry, $F(6, 732) = .43$, $p = .86$. Perceived stress decreased significantly from pretest to postintervention and both follow-ups in all three conditions (see Table 5 for contrast coefficients).The within-group effect sizes (Table 8) indicated that there were small to moderate decreases in worry in all three groups and for all time comparisons (within group d's = -.29 to -.48). At the second follow-up (4-5 weeks postintervention), the within-group effect sizes reflecting change from pretest to follow-up ranged from -.29 to -.48. The largest within-group change occurred in the Mindfulness + Present Control condition (d = -.48). All between-group effect sizes were small (d's = .05 to .19; see Table 9). See Figure 9 for intervention effects on worry.

Completer Analyses

Completer analyses were conducted to see if between-group differences would emerge for those that completed the intervention. It is possible that LMM underestimated how effective the intervention was for those who finished the interventions by including estimations of how early drop outs fared through the course of the intervention. ANCOVA analyses were performed on all measures controlling for baseline scores.

There was a condition effect for mindfulness at postintervention, $F(2, 254) = 5.99$, $p = .003$ and at 1st follow up, $F(2, 265) = 3.41$, $p = .035$. Post hoc tests revealed that, at postintervention, the Mindfulness + Present Control condition and the comparison group conditions had significantly higher scores on mindfulness than the Mindfulness only condition. At 1st follow up, the Mindfulness + Present Control condition had significantly higher scores than the Mindfulness only condition. See Tables 13-15 (Appendix H) for more details on ANCOVA analyses.

Similarly, there was a condition effect for rumination at postintervention, $F(2, 251) = 6.83$, $p = .001$. Post hoc tests showed that, at postintervention, the Mindfulness + Present Control condition had significantly lower scores on rumination than the comparison condition. See Tables 13-15 (Appendix H) for more information.

Additionally, completer analyses using ANCOVA found a marginally significant condition effect for depression at postintervention, $F(2, 254) = 2.84$, $p = .06$. At postintervention the difference between the comparison group's lower scores on depression relative to the Mindfulness only condition was significant ($p = .018$). See Tables 13-15 (Appendix H) for more details.

Lastly, there was a condition effect for perceived stress at postintervention, $F(2,$ 240) $= 4.32$, $p = .014$. At postintervention the Mindfulness + Present Control condition had significantly lower scores on perceived stress (p = .004) than the Mindfulness only condition and the difference between the comparison group's lower scores on perceived stress relative to the Mindfulness only condition was marginally significant ($p =.066$). See Tables 13-15 (Appendix H) for more information. Thus, there was some evidence that the Mindfulness + Present control condition was more effective than the Mindfulness only condition in the completer analyses.

Linear regression analyses were conducted as well to see if the number of logs completed in the intervention conditions would predict outcome, controlling for baseline scores on each outcome. For the most part, they did not. However, there were three notable findings, two of which were marginally significant. The number of stress logs completed predicted lower levels of stress in the Mindfulness only condition at postintervention ($\beta = -.17$, p = .056), they predicted levels of present control in the Mindfulness only condition at 1st follow-up ($\beta = .17$, p = .067) and they predicted levels of anxiety in the Mindfulness + Present Control condition at 1st follow-up ($\beta = -.20$, p = .017). None of the relations between number of logs completed and other outcomes at any time point were significant.

Mediation Analyses

A summary of the hierarchical regression analyses can be found in Table 10. Because there was only one significant time X intervention group interaction (for rumination) all conditions were combined together and mediation was examined for the entire sample instead of for each individual intervention condition. As mentioned, change

scores for each mediator were calculated to reflect change over time from preintervention to final follow-up. Outcome measures in the analyses were from the final follow-up and preintervention scores on each outcome were entered into the first step of the regression model so that the model would control for outcome scores preintervention. In the second step, the change scores for the three mediators were entered. The correlations among the change score measures ranged from $r = -.32$ to .47. Table 10 includes the range of beta coefficients across the five imputed data sets for each predictor and outcome measure, the number of data sets in which the predictor was significantly related to the outcome, the pooled beta coefficient, and the significance of the pooled coefficient. Across the five imputed data sets, the majority of the beta coefficients for the mediator change scores were significant indicating that change in the mediator was associated with follow-up scores, controlling for baseline scores. However, only three of the pooled coefficients for the mediator change scores were significant: change in present control was related to a reduction in depression ($\beta = -.24$); change in rumination was related to a reduction in perceived stress ($\beta = .31$); and change in rumination was related to a reduction in worry ($\beta = .43$). When hierarchical regression is used in SPSS with multiple imputation the significance values for the pooled betas are derived conservatively (Rubin, 1996).

Qualitative Participant Response

Most of the participant feedback regarding the three interventions at postintervention was positive. In response to the question, "Do you plan on continuing additional exercises, similar to the ones you already completed, now that the study is over?" 80% of participants (n = 61/76) in the Mindfulness + Present Control condition replied that they planned to continue using the exercises at least sometimes (sometimes,

fairly often, or very often), compared to 88% (n = 69/78) in the Mindfulness only

condition and 85% (n =81/95) in the comparison group. On a scale from 1-5 with 3 being

"sometimes" and 4 "fairly often", the mean score for each condition was 3.08 for

Mindfulness + Present control, 3.19 for Mindfulness only and 3.13 for the comparison

group.

In response to the question, "If you found the program helpful, please explain

why it was helpful to you" three broad themes emerged from participant responses in the

two mindfulness conditions. The first and by far most endorsed response students

provided for why the Mindfulness + Present Control and Mindfulness conditions were

helpful was that they forced the students to take time out of their busy days to relax and

reflect on their thoughts and feelings. These responses emphasized that students were

busy and forcing them to reflect on what was bothering them and relax was something

they wouldn't have thought to do because of how much work they needed to finish. The

second most endorsed response for these conditions was that the meditations helped

students stop ruminating about their stressors. The third response theme that emerged was

that the meditations helped students accept negative thoughts and feelings and not see

them as threatening. Other comments either didn't answer the question or were only

endorsed by a single person (e.g., "The meditations gave me insight into how stress

affects my behavior"). There were few negative comments regarding the mindfulness

conditions, but some participants reported the meditations as being unhelpful because

they were too repetitive.

Responses from participants in the comparison group could also be broadly

categorized into three themes. The most endorsed response was that students said they

enjoyed receiving multiple strategies for coping with stress because when some strategies didn't work they could turn to others that did. The second most common theme was that students appreciated having a structure to various ways of recognizing and managing stress because if provided an easy reference they could refer back to when they were feeling stressed. The third theme that emerged was that students found the information easy to read and applicable to their daily lives. The only negative feedback received stated the intervention wasn't helpful because the student wasn't in distress.

In response to the question, "Would you have completed the online stress program if you weren't getting extra credit for it?" 44% of respondents (n=46) in the Mindfulness + Present Control condition replied "Maybe", 14% (n=15) said "No" and 13% (n=14) said "Yes". In the Mindfulness only group, 39% of respondents (n=42) replied "Maybe", 14% (n=15) replied "No", and 18% (n=20) replied "Yes". In the comparison group, 51% (n=54) replied "Maybe", 26% (n=27) replied "No" and 15% (n=16) replied "Yes".

The majority of respondents at postintervention responded that the program would be improved if they received personalized messages regarding their exercises (58%, n=185) with the majority (17%, n=55) indicating they would have liked to have received both supportive feedback and tips on stress management. When examining responses, many preferred either supportive feedback or tips on stress management or both (38%, n=121). Lastly, the largest number of participants said they would prefer feedback or personalized messages to be sent to them via email (29%, n=93).

Discussion

The purpose of the current study was to investigate the effects of a 4-week long mindfulness-based Internet delivered intervention on distress levels and to assess mechanisms of change. We also wanted to evaluate whether mindful meditation was best implemented as a complement to a previously designed present control intervention or as a stand-alone intervention. Lastly, we wanted to see how both mindfulness-based interventions compared to a psychoeducational comparison group. To that end we assessed relevant outcome and mediator variables at preintervention, postintervention, and at two separate follow-ups. This study contributed to the existing stress literature by assessing the viability and effectiveness of online mindfulness interventions aimed at reducing stress, by providing evidence of the mechanisms implicated in distress level changes, and by illustrating the effectiveness of online interventions as a treatment modality for university students. Key findings, study limitations and future directions are discussed below.

Efficacy of Interventions in Reducing Mental Health Symptoms

The primary hypothesis, that the intervention groups would be more effective at reducing various mental health outcomes than a psychoeducational comparison group, was not supported. Intent-to-treat analyses using linear mixed modeling found no significant differences between any of the groups on any outcome measure. However, a completer analysis using ANCOVA, which only evaluated participants who completed the intervention and did not estimate how those who dropped out would have performed, found significant between group differences on perceived stress and marginally significant between group differences on depression scores at postintervention. In the

case of perceived stress, the Mindfulness only condition did not perform as well as either

the Mindfulness + Present Control or the comparison groups. For depression, the

Mindfulness only condition did not perform as well as the comparison group. Consistent

with both LMM and ANCOVA analyses, the Mindfulness only condition reduced

negative outcomes the least. However, all three conditions reduced levels of distress

among college students over time, with many of the gains lasting into the second follow-

up. Within group d's from preintervention to the second follow-up 4 to 5 weeks later

were small to moderate (range = -.22 to -.47). The efficacy of the Mindfulness + Present

Control and comparison groups in particular were consistent with the within group effect

sizes seen in other samples using similar interventions emphasizing present control

(within group d's ranged from -.27 to -.37 at postintervention and -.29 to -.56 at follow-

up) using the same measures of distress as the current study (Hintz et al., 2014). The

current study's results for these two groups were also similar to within-group effect sizes

found among mindfulness interventions in the prior two pilot studies where within group

d's ranged from -.21 to -.42 at postintervention and -.29 to -.96 at follow-up. Other

research using mindfulness IBI's also reported similar findings with within-group effect

sizes on similar distress measures ranging from .37 (Cavanaugh et al., 2013) to .50

(Morledge et al., 2013).

　　　　Even though between-group differences were not significant, there was a trend for

the Mindfulness only intervention group to have lower within-group effect sizes on

distress measures (with the exception of perceived stress) than either the Mindfulness +

Present Control group or the comparison group (consistent with the completer analyses).

For example, the mean within-group effect sizes across all distress measures from

preintervention to 2nd follow up for each condition were the following: Mindfulness + Present Control = -.43; Mindfulness only = -.28; Comparison group = -.31. One possible explanation for these differences comes from separate analyses conducted using these data that compared the efficacy of the three intervention conditions among students with and without a history of interpersonal violence (IPV) (Nguyen-Feng et al., 2015). Specifically, there were some differences in the efficacy of the Mindfulness only group between students who reported a history of IPV (who comprised 40% of the sample) and those who did not report a history of IPV. The IPV X condition X time interaction was significant for depression, anxiety and rumination. For example, for anxiety, within-group effect sizes in the Mindfulness only group from preintervention to the second follow-up were d = .03 for those with a history of IPV and d = -.39 for those with no history of IPV. These differences between the IPV and no-IPV groups did not exist for the other intervention groups. For instance, returning to anxiety, in the Mindfulness + Present Control group, within-group effect sizes from preintervention to the second follow-up were d = -.39 for those with a history of IPV and d = -.41 for those without; for the comparison group, they were d = -.25 for those with IPV and d = -.31 for those without. It is possible then, that those with a history of IPV might not be suitable for a Mindfulness only intervention that doesn't also incorporate some psychoeducation on present control.

It was not clear why the Mindfulness only group reduced perceived stress to a considerable degree (within group d = -.55) but not stress symptoms (within group d = -.19). One possibility is that questions on the perceived stress measure relate more to global feelings of confidence and ability to handle stress (e.g., "In the last month, how

often have you felt confident about your ability to handle your personal problems?") whereas the stress measure targets more specific behavioral symptoms of stress (e.g., "I found it difficult to relax"). It is possible that the Mindfulness only intervention helps students feel more in control of the stress they experience despite the persistence of symptoms of stress (e.g., "I was aware of dryness in my mouth"). Indeed, prior research has theorized that mindful meditation helps change how one perceives and manages stress and anxiety though this might not translate to a comparable reduction of stress per se (Shapiro et al., 2006). In other words, participants may experience more reductions in perceived stress than stress because of how they have learned, through meditation, to relate to that stress differently and with more equanimity, especially as it relates to one's ability to confidently complete important life tasks.

Another important finding was that the comparison group was as effective as the two intervention groups. The comparison group incorporated psychoeducation on stress and provided tips for managing stress that came from a university counseling center's web resources for students. It is possible that the comparison group was effective because many of the suggestions for how to deal with stress were similar to the techniques and theory in the active intervention conditions. For example, some tips for managing stress the comparison group read included "Learn to accept what you cannot change" and "Learn relaxation techniques…like meditation" which were similar to the mindfulness interventions. Moreover, suggestions such as "Practice time management" and "Break down big projects into small tasks" and "Prioritize your stressors" are similar to the present control aspect of the Mindfulness + Present control intervention. Though there was little explanation of how to incorporate these suggestions, perhaps all that is required

to produce small to moderate changes in distress is to suggest alternative ways to manage stress. Also, as changes in present control mediated the effects of the interventions on depression, providing students with behaviors to engage may be enough to raise present control, promote self-agency, and reduce stress. In other words, any intervention that makes students believe they can do something about their stress, regardless of what that something might be, could be effective.

Intervention Effects on Proposed Mediators

Our hypothesis that the intervention groups would increase present control and mindfulness and reduce levels of rumination more than the comparison group was also mostly not supported according to our intent-to-treat analysis. There were no significant between group differences for either present control or mindfulness. There were significant between group differences detected using ANCOVA with the Mindfulness + Present Control and comparison group conditions both increasing mindfulness more than the Mindfulness only condition at post-test and the Mindfulness + Present Control condition increasing mindfulness more than the Mindfulness only condition at 1st follow-up.

For present control, one reason for the lack of differences could be that the Mindfulness + Present Control intervention did not target present control the way prior iterations of the intervention have (Hintz et al., 2014). In the current study, across all conditions, present control increased between $d = .25$ (Mindfulness Only) to $d = .38$ (Mindfulness + Present control) from pretest to 2nd follow-up which represents less change than in the original present control intervention (within group d's ranged from .58 to .64 in the aforementioned pilot studies). These changes in present control were similar

to those in the Mindfulness condition in the second pilot study ($d = .35$) but not the first ($d = .68$). One explanation for this is that, compared to the original present control intervention where participants completed several stress logs and explicitly identified stressors and what they can do about them, the current intervention only supplied psychoeducation about present control with only a single concomitant stress log. As such, the other interventions all similarly provide something to do about one's stress, whether meditating or providing advice on how to manage stress (e.g. in the comparison group, many of the psychoeducational components suggest ways of relaxing and unwinding). This may be enough to foster some sense of present control but not as much as interventions that focus more specifically on present control.

Regarding increases in mindfulness as a mechanism of change, although between-group differences were not significant, between group effect sizes showed that the Mindfulness + Present control group increased mindfulness at postintervention more than the Mindfulness only group ($d = .40$) and more than the comparison group ($d = .27$). The Mindfulness only group also increased mindfulness more than the comparison group, although the difference was small ($d = .13$). Of significance, mindfulness increased in all three conditions across time from postintervention to second follow-up. The within-group effect sizes in the Mindfulness + Present Control group increased from $d = .37$ (postintervention) to .71 (second follow-up), the Mindfulness only group increased from $d = .15$ (postintervention) to .42 (second follow-up), and the comparison group increased from $d = .28$ (postintervention) to .50 (second follow-up). For the mindfulness groups, this pattern is logical given that increased practice with meditation should increase proficiency, which in turn should increase mindfulness over time. Evidence for this is

suggested by the small to non-existent changes in mindfulness at midintervention assessment that increased considerably by postintervention. Differences in within group effect sizes in mindfulness might also reflect the different meditations the mindfulness conditions incorporated. It is possible that the Mindfulness + Present control group's greater increases were due to listening to the same meditation for the duration of the study as opposed to the Mindfulness only group's listening to four different meditations. Listening to the same meditation might help develop mindfulness better than listening to separate meditations focusing on different aspects of being mindful (e.g., focusing on breath one week, physical sensations the next, thoughts and feelings the next). For the comparison group, though the increases in mindfulness weren't as large as the other conditions, perhaps they too were the result of greater familiarity with suggested stress management techniques gained over time.

Returning to the lack of between group differences, it is possible that merely drawing attention to one's stressors is enough to make people more aware of how those stressors affect one. For instance, in the comparison group, one of the psychoeducational worksheets provided information on 'Distress Symptoms or Signals', many of which draw attention to one's physiological and mental states (e.g. 'difficult breathing' and 'irritability'). Perhaps all it takes to increase levels of mindfulness in a mostly non-distressed population is to have students think about mental and physiological changes associated with stress in relation to their own experience.

There was, however, a significant difference between groups in reducing rumination; this part of our hypothesis was supported. The largest difference occurred at postintervention with the Mindfulness + Present control group decreasing rumination

more than the Mindfulness only group ($d = .24$) and the comparison group ($d = .52$) and the Mindfulness only group reducing rumination more than the comparison group ($d = .28$). The completer analysis showed that the Mindfulness + Present Control group reduced rumination more than the comparison group, but other between group differences were not significant. Additionally, the mindfulness interventions reduced rumination from pretest to postintervention more than the mindfulness and present control intervention in our first pilot study (d's for Mindfulness + Present Control and Mindfulness only both $= -.45$ versus the first pilot study, $d = -.34$) but not the second pilot study where the within-group effect size for the mindfulness condition was $d = -.96$. These results are in line with prior research indicating that mindful meditation is effective at reducing rumination (Jain et al., 2007). If the above explanations for why there were no significant differences in mindfulness are true, it may be that although drawing attention to one's experience is enough to increase levels of mindfulness, even if only through psychoeducation, meditation is required to significantly reduce the rumination that often accompanies higher levels of stress and anxiety. It is also notable that the Mindfulness + Present Control group reduced rumination more than the Mindfulness only group. This indicates that psychoeducation on present control combined with meditative practice provides additive benefit relative to meditation by itself. This could be due to the way present control psychoeducation provides students with a way of identifying stressors and doing something about them, which may reduce the propensity to ruminate.

Mechanisms of Change

The hypotheses that changes in proposed mediators would explain changes in distress were only partially supported. Specifically, changes in present control were

moderately related to reductions in depression ($\beta = -.24$) but not any other outcome. This was somewhat less than the mediation effect of present control found in prior research where the same relationship was a stronger albeit using a different intervention focusing only on present control and a different method of testing for mediation ($\beta = -.37$; Hintz et al., 2014). Changes in rumination also had an effect on perceived stress and worry ($\beta = .31$ and $\beta = .43$, respectively). It is unclear why rumination would not be related to other outcomes, especially stress and anxiety. One possible explanation for the lack of significant mediators could be methodological.

When conducting hierarchical regression with multiple imputation, significance tests on the pooled betas are conservative and may overestimate significance values (Rubin, 1996). Consequently, it is instructive to examine the number of significant tests across imputations. For instance, though changes in present control were only related to depression in the pooled estimate, an examination of the data showed that present control significantly related to anxiety in 5 out of the 5 imputed data sets, though the pooled estimate was not significant ($p = 07$). The beta coefficients for present control's relationship to anxiety ranged from -.21 to -.41 across the imputed data sets and this variation likely accounted for the pooled estimate being non-significant. Moreover, present control was significantly related to perceived stress in 4 out of 5 imputed data sets though again the pooled estimate was not significant ($p = .08$). Present control was only related to stress in 2 out of 5 imputed data sets and 3 out of 5 for worry. It is possible that with a less conservative estimation that present control would be related to anxiety and perceived stress as well as depression.

A similar pattern was present when examining mindfulness. Though changes in mindfulness were not found to be significantly related to any outcomes, mindfulness beta coefficients were significant in 4 out of 5 imputed data sets for every outcome. It is again possible that were the estimation less conservative changes in mindfulness would be significantly related to all outcome variables. There was, however, considerable variation in the ranges of mindfulness betas computed for outcome across the imputed data sets. For instance, the largest range was detected for perceived stress which varied from -.06 to -.45. Given this wide variation it is difficult to assess the true relationship.

Rumination was significantly related to anxiety and stress in 4 out of 5 imputed data sets though the pooled p-values were not significant (p's = 14 and .13 respectively). Again, it is possible that rumination was related not just to worry and perceived stress but to these outcomes as well, though the beta coefficient ranges were quite small (e.g. .05-.18 for the relationship to stress).

Limitations

There were several limitations to the current study. First, the sample was primarily comprised of white women, which limits the generalizability of the findings. Second, there was considerable attrition from pretest to posttest with about a third of the intervention groups dropping out of the study. This was somewhat more than the quarter of students who dropped out of the comparison group condition. This attrition rate was higher at post-test than in our other studies although it is not clear why (e.g., Hintz et al., 2014). However, the attrition at 1st and 2nd follow up was relatively stable and similar or better to rates found in other research using IBIs with college students(e.g., Cavanaugh et al., 2013). Third, the intervention was interrupted by spring break, which could have

affected distress levels of students in various hard to predict ways. Fourth, students

received extra credit for participating in the study, which compromised the ecological

validity of the findings. Additionally, it is unclear if the interventions as constructed

constituted a 'mindfulness' intervention per se. The meditations were created by the

author of this study but were not standardized according to prior research (e.g., there was

no standard dose of mindfulness administered similar to that found in a course of

Mindfulness Based Stress Reduction). As such, it is possible that a lack of between group

differences was due to the interventions not truly representing a standardized

administration of mindfulness. Also, the present control aspects of the Mindfulness plus

Present Control condition were altered from prior iterations (e.g. fewer stress logs were

administered in this study than in prior versions of mindfulness combined with present

control interventions discussed earlier). It is possible this alteration accounted for the lack

of between group differences detected in prior research, but not in the current study, as

well. Finally, the participants were students who were primarily low in distress. A lack of

significant findings could be due to too few students having been in distress for

meaningful differences to have been captured. Thus, the study might be better described

as involving prevention than intervention.

Implications for Training and Practice

This study demonstrates that mindful meditation can be incorporated into an

online format to reduce symptoms of distress including rumination, and increase present

control and mindfulness. Although there were no significant between group differences

between the mindfulness-based intervention groups and the comparison group,

mindfulness IBIs were successful in reducing distress levels on average even among

students who, taken as a whole, showed mostly no to mild levels of distress. Given how easy, cost-effective and private IBIs are, it would make sense for universities to offer a variety of IBIs to help students manage stress, with different theoretical modalities likely helping students to different degrees for as yet unknown reasons. For example, there is some evidence that meditation absent a present control psychoeducational component was not as helpful for students with a history of interpersonal violence (Nguyen-Feng et al., 2015). There are likely other student variables likely to influence the effectiveness of IBIs as well. As those variables are as yet unknown, it is especially important that universities interested in helping the broadest array of students should likewise offer a broad array of IBIs to most comprehensively reduce student stress, especially when more traditional psychotherapy resources are limited. Indeed, the advantage of IBIs is that they can be administered privately, inexpensively and with few barriers to access compared to conventional counseling. Universities and colleges should consider incorporating IBIs into their array of mental health services given student comfort with social media and using the web in general. Universities might also consider sending out links to stress management techniques given the results of the current study's comparison group.

Future Directions

The current study suggests there are a number of avenues future research should explore. First, it is as yet unknown why there were no significant between-group differences. Future studies should determine which forms of intervention work best for which students. Identifying important variables characterizing students likely to respond to particular intervention modalities is necessary to optimize intervention effectiveness. Second, future research should evaluate the effectiveness of IBIs in a more distressed

population. This study included mostly high functioning college students. On average, the IBIs still produced small to moderate effects, but it is possible that the IBIs would be even more effective and show between group differences, in a sample that was more distressed. Third, the relationships between alleged mediators and outcomes were mostly non-significant in the pooled analyses. Other studies should look at alternative mediators, including self-compassion, as a possible explanation for why the interventions were effective. To determine if the interventions are exerting an effect on outcomes, future studies should compare the treatment groups with no treatment controls as opposed to a psychoeducational control group to rule out the chance that time, or the cessation of the semester were in fact responsible for observed changes in distress as opposed to the interventions. As more web services are also offered on smartphones, future research should look at adapting current online delivery systems for mental health interventions on mobile platforms. To date there are few quality randomized controlled trials that evaluate mobile mental health apps despite them becoming popular over the last several years (Donker et al., 2013). Finally, given that the Mindfulness + Present Control condition seemed to produce the largest effect sizes among outcomes evaluated, future research could explore more fully integrating the original present control intervention along with attendant stress logs with mindful meditation to see if there is additive benefit to combining two, at least seemingly different treatment modalities in a single intervention.

Table 1

Means and Standard Deviations on Mediator Measures Across Time Points

	Mindfulness + Present Control					Mindfulness Only					Comp				
	Pretest N=105 M(SD)	Midtest N=78-79 M(SD)	Posttest N=75-76 M(SD)	1st F-u N=77-81 M(SD)	2nd F-u N=73-74 M(SD)	Pretest N=107-109 M(SD)	Midtest N=76-77 M(SD)	Posttest N=80-81 M(SD)	1st F-u N=83-86 M(SD)	2nd F-u N=76 M(SD)	Pretest N=106 M(SD)	Midtest N=85-87 M(SD)	Posttest N=98 M(SD)	1st F-u N=93-99 M(SD)	2nd F-u N=90 M(SD)
Present Control	3.01 (.51)	3.19 (.49)	3.20 (.58)	3.18 (.50)	3.22 (.52)	2.98 (.54)	3.15 (.53)	3.13 (.55)	3.13 (.48)	3.13 (.51)	3.03 (.52)	3.16 (.48)	3.20 (.49)	3.20 (.49)	3.20 (.49)
Mindfulness	3.22 (.43)	3.28 (.46)	3.47 (.50)	3.48 (.53)	3.54 (.57)	3.14 (.54)	3.16 (.56)	3.21 (.56)	3.25 (.56)	3.37 (.54)	3.25 (.49)	3.27 (.49)	3.41 (.52)	3.44 (.56)	3.48 (.56)
Rumination	4.89 (1.10)	4.70 (1.11)	4.26 (1.29)	4.51 (1.10)	4.36 (1.30)	5.07 (1.21)	4.98 (1.09)	4.63 (1.19)	4.70 (1.00)	4.52 (1.40)	4.82 (1.25)	4.72 (1.09)	4.67 (1.25)	4.48 (1.25)	4.41 (1.46)

Note. M = mean, SD = standard deviation. Sample values are reported at each time period. Analyses reported in the text used an intent-to-treat approach with missing data estimated using restricted maximum likelihood estimation for linear mixed models. Present Control responses are scored 1 (Strongly Disagree) to 5(Strongly Agree). Mindfulness responses are scored 1 (Never or very rarely true) to 5 (Very often or always true). Rumination responses are scored 1 (not at all) to 7 (very much).

Table 2

Means and Standard Deviations on Outcome Measures Across Time Points

	Mindfulness + Present Control				Mindfulness Only				Comparison Group			
	Pretest N=105 M(SD)	Posttest N=102-105 M(SD)	1st Follow-up N=75-76 M(SD)	2nd Follow-up N=69-74 M(SD)	Pretest N=106-109 M(SD)	Posttest N=109 M(SD)	1st Follow-up N=79-81 M(SD)	2nd Follow-up N=71-76 M(SD)	Pretest N=102-106 M(SD)	Posttest N=94-98 M(SD)	1st Follow-up N=96-99 M(SD)	2nd Follow-up N=85-90 M(SD)
DASS Stress	2.20 (.56)	2.06 (.57)	2.00 (.59)	1.95 (.59)	2.33 (.68)	2.25 (.66)	2.19 (.62)	2.21 (.64)	2.23 (.64)	2.03 (.61)	1.97 (.66)	2.01 (.67)
DASS Anxiety	1.65 (.54)	1.57 (.53)	1.52 (.50)	1.43 (.47)	1.76 (.58)	1.73 (.59)	1.67 (.62)	1.65 (.67)	1.65 (.58)	1.56 (.54)	1.49 (.56)	1.52 (.51)
DASS Depression	1.78 (.59)	1.65 (.54)	1.61 (.57)	1.58 (.59)	1.88 (.69)	1.80 (.68)	1.72 (.63)	1.73 (.68)	1.80 (.67)	1.60 (.54)	1.65 (.66)	1.58 (.51)
Perceived Stress	2.27 (.53)	1.95 (.56)	2.01 (.58)	2.02 (.55)	2.36 (.60)	2.22 (.63)	2.06 (.56)	2.03 (.61)	2.30 (.69)	2.06 (.60)	1.99 (.62)	2.06 (.56)
Worry	3.53 (.78)	3.29 (.80)	3.22 (.87)	3.16 (.90)	3.66 (.83)	3.58 (.89)	3.38 (.87)	3.42 (.85)	3.50 (.81)	3.33 (.86)	3.15 (.93)	3.24 (.92)

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Note. *M* = mean, *SD* = standard deviation. Sample values are reported at each time period. Analyses reported in the text used an intent-to-treat approach with missing data estimated using restricted maximum likelihood estimation for linear mixed models. DASS responses are scored 0 (Never) to 3 (Almost always). Perceived stress responses are scored 0 (never) to 4 (very often). Worry responses are scored 0 (Almost never) to 4 (Almost always).

Table 3

Preintervention Correlations

Measure	1	2	3	4	5	6	7	8
1. Present Control	-	-	-	-	-	-	-	-
2. Mindfulness (FFMQ)	.54**	-	-	-	-	-	-	-
3. Rumination	-.37**	-.56**	-	-	-	-	-	-
4. DASS Stress	-.46**	-.50**	.51**	-	-	-	-	-
5. DASS Depression	-.55**	-.58**	.48**	.60**	-	-	-	-
6. DASS Anxiety	-.44**	-.47**	.46**	.65**	.60**	-	-	-
7. Perceived Stress	-.51**	-.49**	.44**	.68**	.65**	.56**	-	-
8. Worry	-.43**	-.51**	.61**	.58**	.44**	.49**	.62**	-

*Note. N = 320. **p<.001.*

Table 4

Linear Mixed Models of Intervention Effects on Mediator Variables

	Mindfulness + Present Control Contrasts				Mindfulness Only Contrasts				Comparison Contrasts			
	Pretest to Midtest	Pretest to Posttest	Pretest to 1st follow-up	Pretest to 2nd follow-up	Pretest to Midtest	Pretest to Posttest	Pretest to 1st follow-up	Pretest to 2nd follow-up	Pretest to Midtest	Pretest to Posttest	Pretest to 1st follow-up	Pretest to 2nd follow-up
Present Control	.16***	.19**	.17**	.19**	.17***	.15*	.14*	.13*	.14**	.15**	.17**	.17**
Mindfulness	.04	.24***	.25***	.31***	0	.07	.12*	.22***	0	.13**	.18***	.24***
Rumination	.14	.68***	.53***	.50**	.16	.46***	.46***	.55***	.10	.13	.47***	.46**

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*Note. N = 320. * p<.05 ** p<.01 *** p<.001.* Values are estimated coefficients from linear mixed model analyses reflecting change over time within groups.

Table 5

Linear Mixed Models of Intervention Effects on Outcome Variables

	Mindfulness + Present Control Contrasts			Mindfulness Only Contrasts			Comparison Contrasts		
	Pretest to Posttest	Pretest to 1st follow up	Pretest to 2nd follow up	Pretest to Posttest	Pretest to 1st follow up	Pretest to 2nd follow up	Pretest to Posttest	Pretest to 1st follow up	Pretest to 2nd follow up
Dass Stress	.21***	.25***	.25**	.18**	.13*	.13	.26***	.22***	.22**
Dass Anxiety	.13**	.22***	.22***	.09*	.10	.10	.17***	.13*	.13*
Dass Depression	.14**	.18**	.18*	.14**	.13*	.14	.15**	.22***	.21**
Perceived Stress	.26***	.25***	.25***	.32***	.33***	.33***	.32***	.24***	.23**
Worry	.33***	.37***	.37***	.31***	.24**	.24**	.34***	.27***	.27**

*Note. N = 320. * p<.05 ** p<.01 *** p<.001*. Values are estimated coefficients from linear mixed model analyses reflecting change over time within groups.

Table 6

Within Group Effect Sizes (Cohen's d) for Mediator Variables

Variable	Condition	Preintervention - Midintervention	Preintervention - Postintervention	Preintervention - 1st follow-up	Preintervention - 2nd follow-up
Present Control	MF+PC	.32	.37	.34	.38
	MF	.32	.28	.27	.25
	Comparison	.27	.30	.33	.34
Mindfulness	MF+PC	.09	.54	.58	.71
	MF	.01	.15	.23	.42
	Comparison	0	.28	.37	.50
Rumination	MF+PC	-.13	-.62	-.48	-.45
	MF	-.13	-.38	-.38	-.45
	Comparison	-.08	-.10	-.38	-.37

Note. Positive *d*'s indicate increases in scores over time and negative *d*'s indicate decreases.

Table 7

Between Group Effect Sizes (Cohen's d) for Mediator Variables

Variable	Condition	Mid	Post	1st follow-up	2nd follow-up
Present Control	MF+PC vs MF	0	.09	.06	.13
	MF+PC vs Comparison	.04	.07	.01	.04
	MF vs Comparison	.04	.02	.06	.08
Mindfulness	MF+PC vs MF	.10	.40	.35	.29
	MF+PC vs Comparison	.09	.27	.21	.21
	MF vs Comparison	.01	.13	.14	.08
Rumination	MF+PC vs MF	0	-.24	-.10	0
	MF+PC vs Comparison	-.05	-.52	-.1	-.08
	MF vs Comparison	-.05	-.28	0	-.09

Note. Positive *d*'s indicate the first group in comparison had larger within-group effect sizes; negative *d*'s indicate the second group in the comparison had larger within-group effect sizes.

Table 8 *Within Group Effect Sizes (Cohen's d) for Outcome Variables*

Variable	Condition	Preintervention - Postintervention	Preintervention - 1st follow-up	Preintervention - 2nd follow-up
Stress	MF+PC	-.38	-.45	-.45
	MF	-.26	-.19	-.19
	Comparison	-.41	-.35	-.35
Anxiety	MF+PC	-.25	-.41	-.42
	MF	-.15	-.18	-.18
	Comparison	-.30	-.22	-.22
Depression	MF+PC	-.25	-.30	-.31
	MF	-.20	-.19	-.19
	Comparison	-.23	-.33	-.32
Perceived Stress	MF+PC	-.49	-.48	-.47
	MF	-.54	-.56	-.55
	Comparison	-.47	-.36	-.34
Worry	MF+PC	-.42	-.48	-.48
	MF	-.37	-.29	-.29
	Comparison	-.42	-.34	-.33

Note. Positive *d*'s indicate increases in scores over time and negative *d*'s indicate decreases.

Table 9

Between Group Effect Sizes (Cohen's d) for Outcome Variables

Variable	Condition	Preintervention - Postintervention	Preintervention - 1st follow-up	Preintervention - 2nd follow-up
Stress	MF+PC vs MF	.11	.25	.26
	MF+PC vs Comparison	-.03	.10	.10
	MF vs Comparison	-.14	-.15	-.16
Anxiety	MF+PC vs MF	.09	.23	.23
	MF+PC vs Comparison	-.05	.19	.19
	MF vs Comparison	-.14	-.04	-.04
Depression	MF+PC vs MF	.05	.12	.12
	MF+PC vs Comparison	.02	-.02	-.01
	MF vs Comparison	-.03	-.14	-.13
Perceived Stress	MF+PC vs MF	-0.04	-.08	-.08
	MF+PC vs Comparison	.02	.12	.13
	MF vs Comparison	.07	.20	.21
Worry	MF+PC vs MF	.05	0.20	.19
	MF+PC vs Comparison	0	.14	.15
	MF vs Comparison	-.05	-.05	-.05

Note. Positive *d*'s indicate the first group in comparison had larger within-group effect sizes; negative *d*'s indicate the second group in the comparison had larger within-group effect sizes.

Table 10

Summary of Hierarchical Regression Analysis for Outcome Variables at 2nd Follow-up

	Variable	Range of *βs* across imputations	# of significant tests	Pooled *β*	Pooled *t*	Pooled p
Step 1	**Anxiety Preintervention**	.32 to.44	5	0.40	5.55	.001
Step 2	Present Control Change Preintervention to 2nd Follow-up	-.21 to -.41	5	-0.26	-2.18	.07
	Mindfulness Change Preintervention to 2nd Follow-up	-.03 to -.24	4	-0.15	-1.56	.16
	Rumination Change Preintervention to 2nd Follow-up	.04 to .16	4	0.20	1.70	.14
Step 1	**Depression Preintervention**	.31 to .39	5	.38	5.99	.001
Step 2	Present Control Change Preintervention to 2nd Follow-up	-.18 to -.29	5	-.24	-3.47	.002
	Mindfulness Change Preintervention to 2nd Follow-up	-.03 to -.21	4	-0.13	-1.48	.17
	Rumination Change Preintervention to 2nd Follow-up	-.01 to .10	3	0.11	.96	.37
Step 1	**Stress Preintervention**	.40 to .48	5	.42	6.55	.001
Step 2	Present Control Change Preintervention to 2nd Follow-up	-.07 to -.20	2	-.11	-1.43	.18
	Mindfulness Change Preintervention to 2nd Follow-up	-.03 to -.19	4	-0.13	-1.56	.15
	Rumination Change Preintervention to 2nd Follow-up	.05 to .18	4	.20	1.75	.13
Step	**Perceived Stress**			.33	6.03	

1	**Preintervention**	.32 to .35	5			.001
Step 2	Present Control Change Preintervention to 2nd Follow-up	-.07 to -.30	4	-0.21	-2.03	.08
	Mindfulness Change Preintervention to 2nd Follow-up	-.06 to -.45	4	-0.22	-1.50	.19
	Rumination Change Preintervention to 2nd Follow-up	.12 to .20	5	0.31	4.26	.001
Step 1	**Worry Preintervention**	.65 to .69	5	.59	12.37	.001
Step 2	Present Control Change Preintervention to 2nd Follow-up	-.06 to -.21	3	-0.09	-1.58	.14
	Mindfulness Change Preintervention to 2nd Follow-up	-.11 to -.34	4	-0.12	-1.61	.15
	Rumination Change Preintervention to 2nd Follow-up	.31 to .35	5	.43***	10.10	.001
	Values are standardized coefficients pooled across five imputed data sets.					

Figure 1. Participant Recruitment and Attrition

Enrollment

Assessed for eligibility (n=401)

Excluded (n=36)
- Declined to participate (n=32)
- Asked to be withdrawn (n=4)

Randomized (n=365)

Pre-Test

Allocated to PC+Mindfulness Condition (n=121)

Allocated to Mindfulness Condition (n=122)

Allocated to Comparison Condition (n=122)

Post-Test

Total participants (n=76)
Total lost to attrition (n=45)

Total participants (n=81)
Total lost to attrition (n=41)

Total participants (n=98)
Total lost to attrition (n=24)

1st- Follow-up

Total participants (n=81)
Total lost to attrition (n=40)

Total participants (n=85)
Total lost to attrition (n=37)

Total participants (n=99)
Total lost to attrition (n=23)

2nd- Follow-up

Total participants (n=74)
Total lost to attrition (n=47)

Total participants (n=75)
Total lost to attrition (n=47)
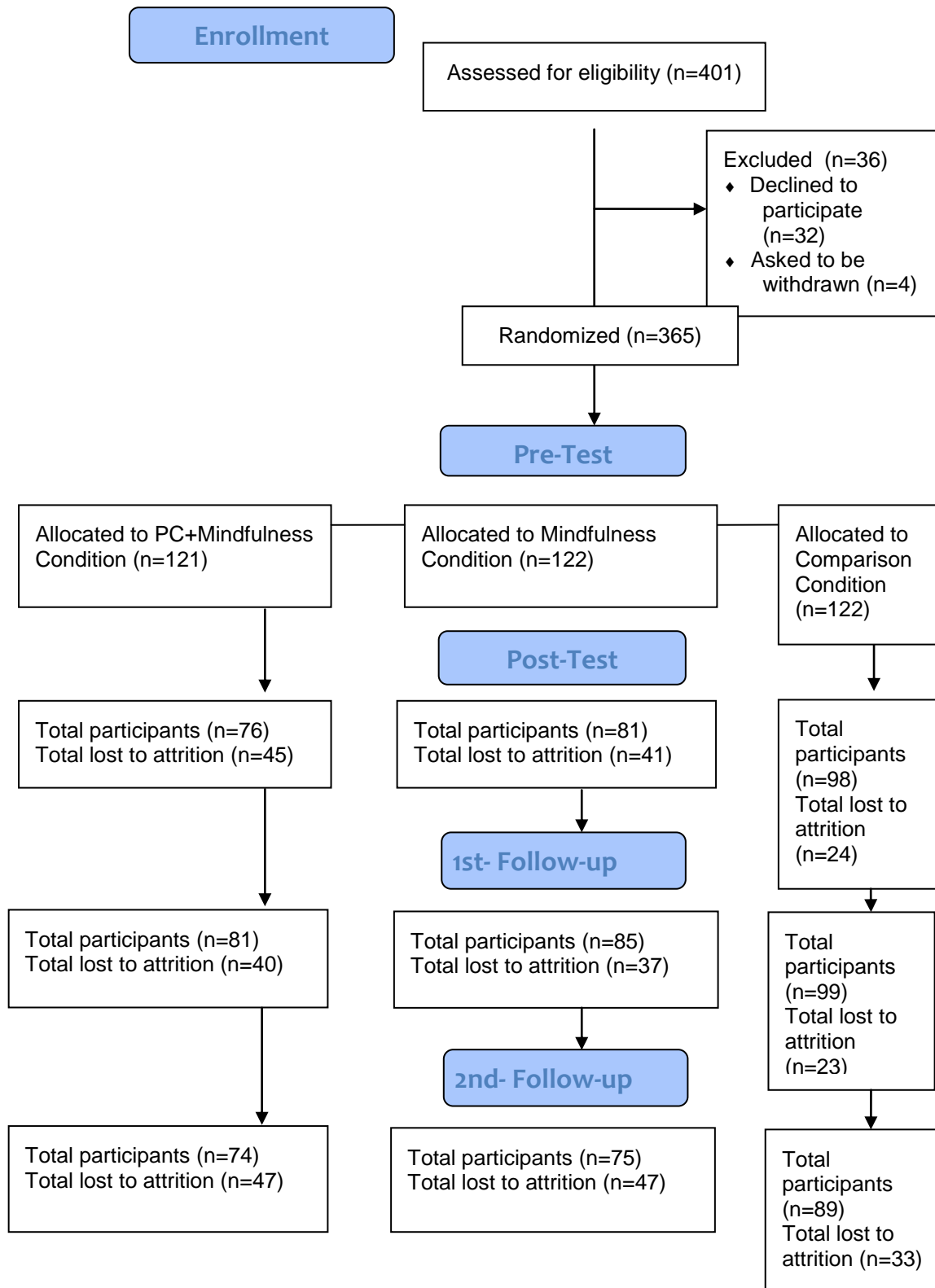
Total participants (n=89)
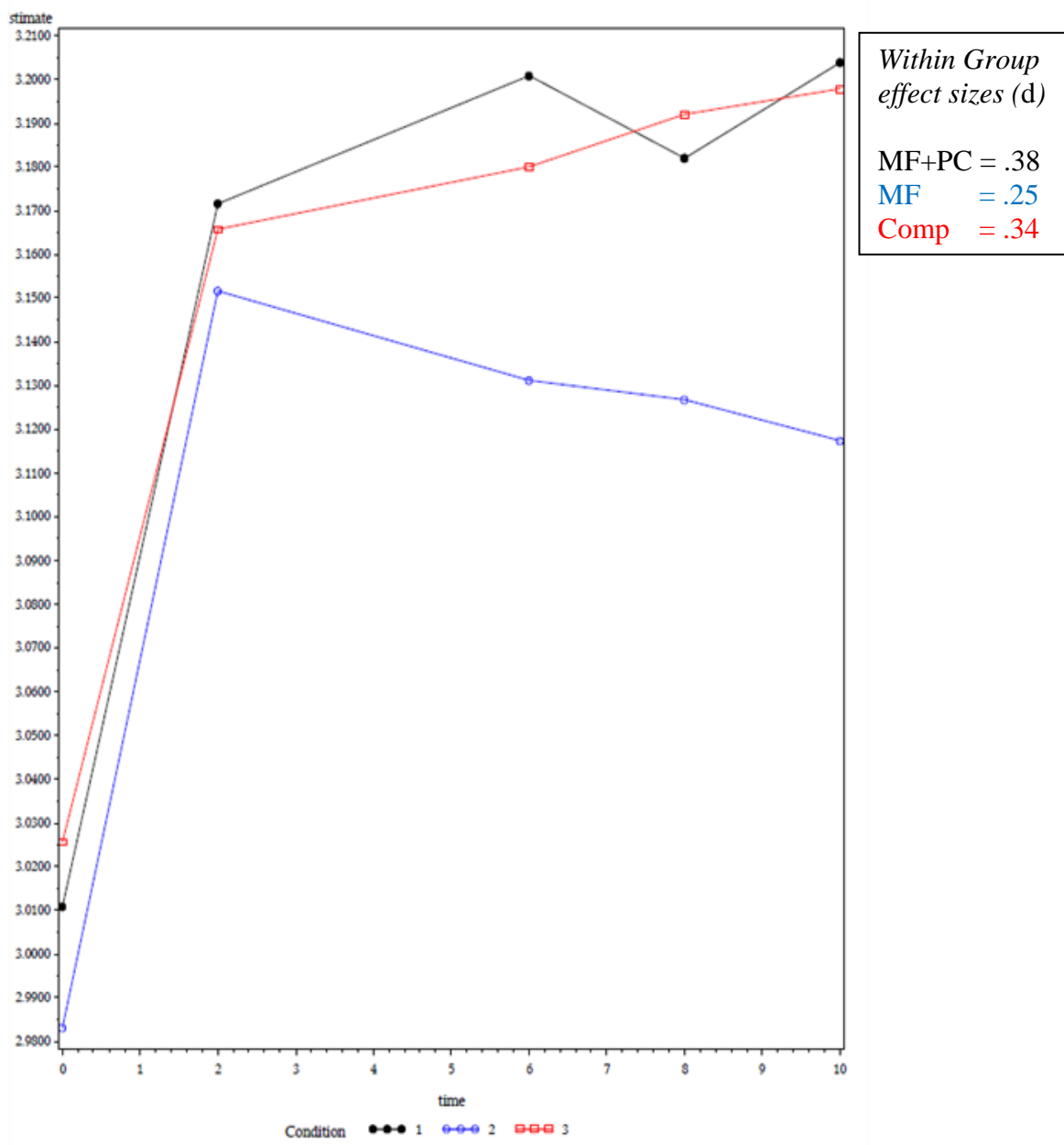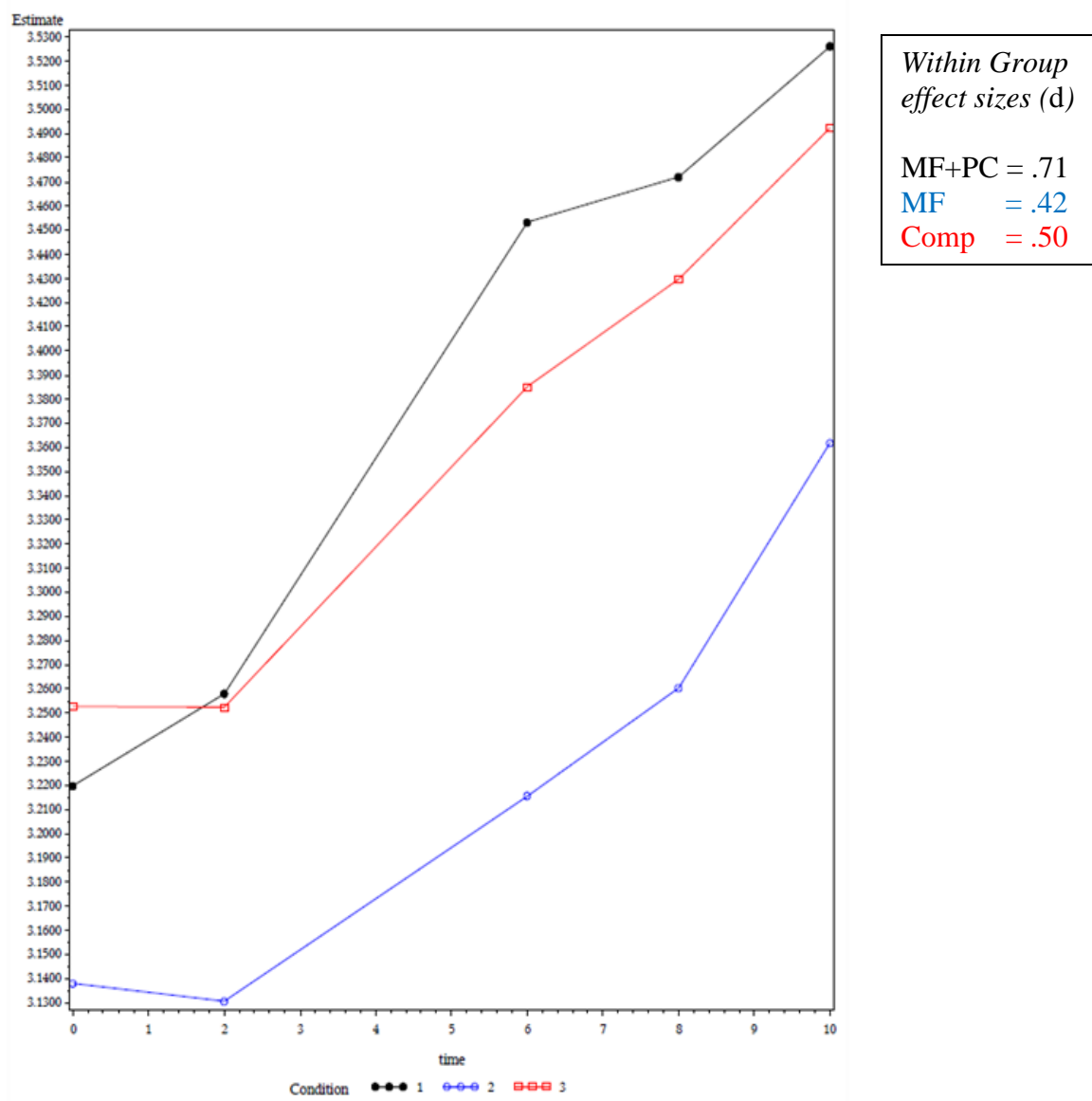Total lost to attrition (n=33)

Figure 2. Intervention Effects on Present Control

Note. 1=Mindfulness plus Present Control, 2=Mindfulness Only, 3=Comparison Group. Within-group effect sizes are from preintervention to 2nd follow-up.

Figure 3. Intervention Effects on Mindfulness (FFMQ)

Note. 1=Mindfulness plus Present Control, 2=Mindfulness Only, 3=Comparison Group. Within-group effect sizes are from preintervention to 2nd follow-up.

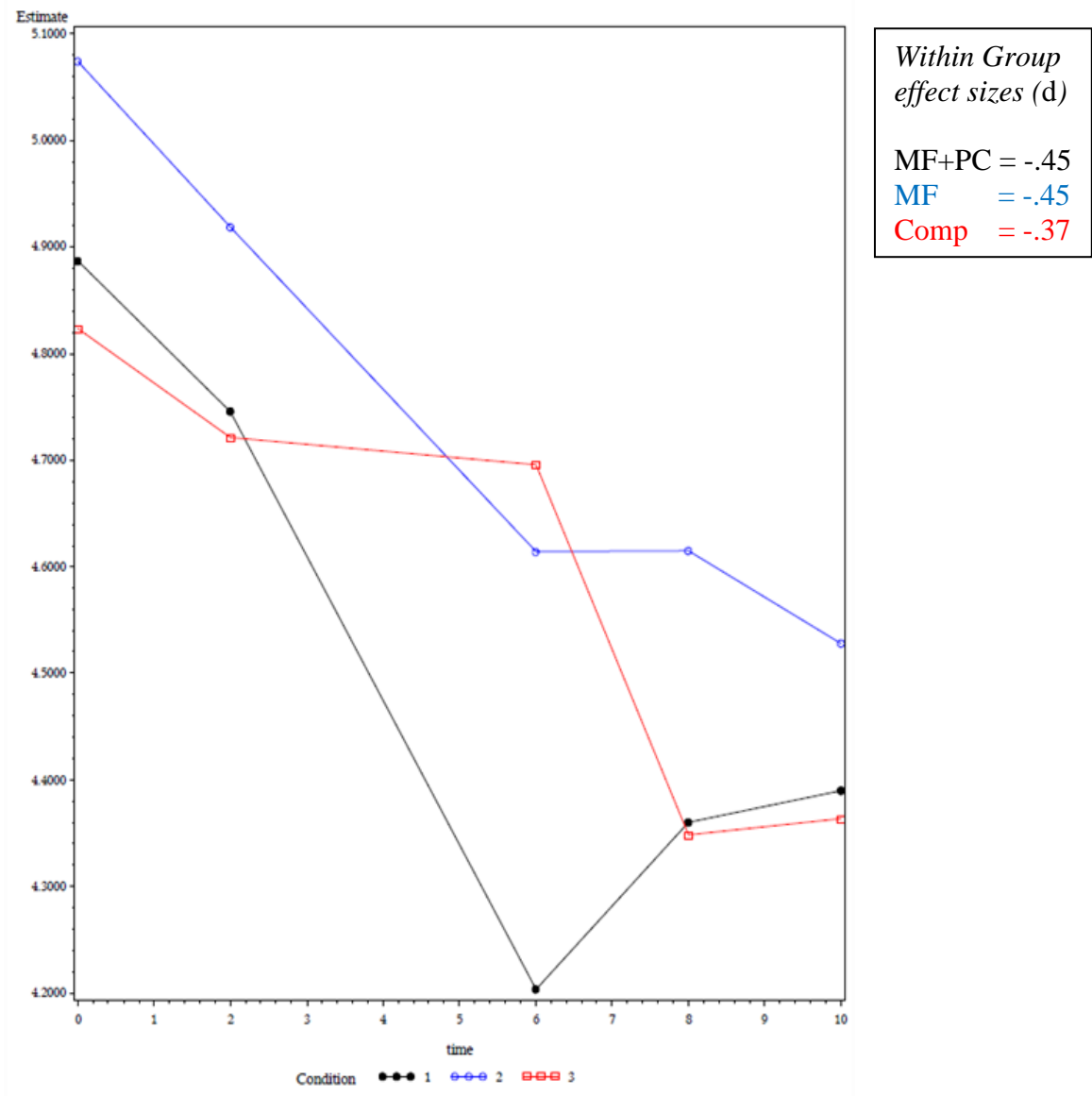Figure 4. Intervention Effects on Rumination

Note. 1=Mindfulness plus Present Control, 2=Mindfulness Only, 3=Comparison Group. Within-group effect sizes are from preintervention to 2nd follow-up.

Figure 5. Intervention Effects on Stress
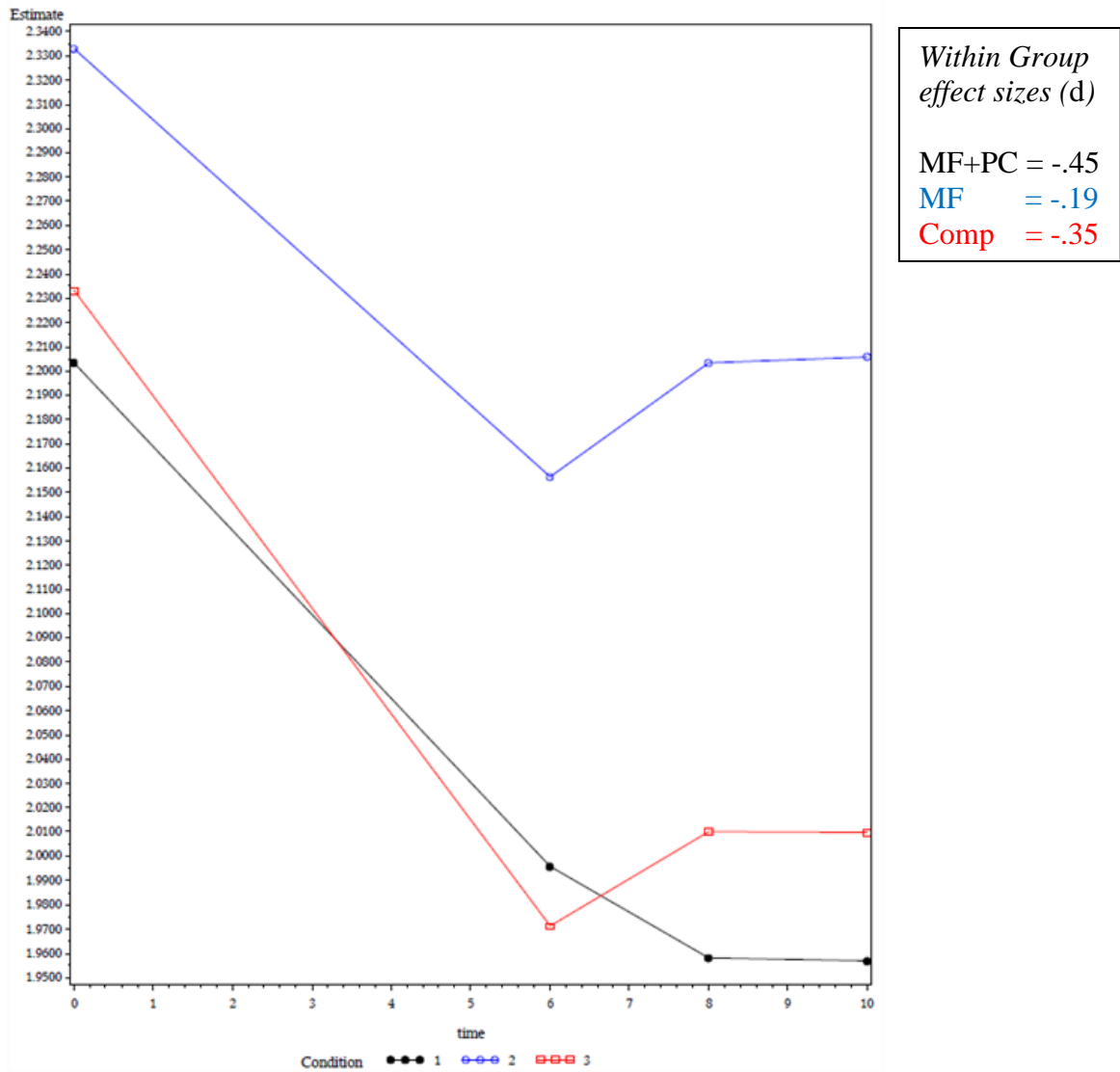

Note. 1=Mindfulness plus Present Control, 2=Mindfulness Only, 3=Comparison Group. Within-group effect sizes are from preintervention to 2nd follow-up.

Figure 6. Intervention Effects on Anxiety

Note. 1=Mindfulness plus Present Control, 2=Mindfulness Only, 3=Comparison Group. Within-group effect sizes are from preintervention to 2nd follow-up.
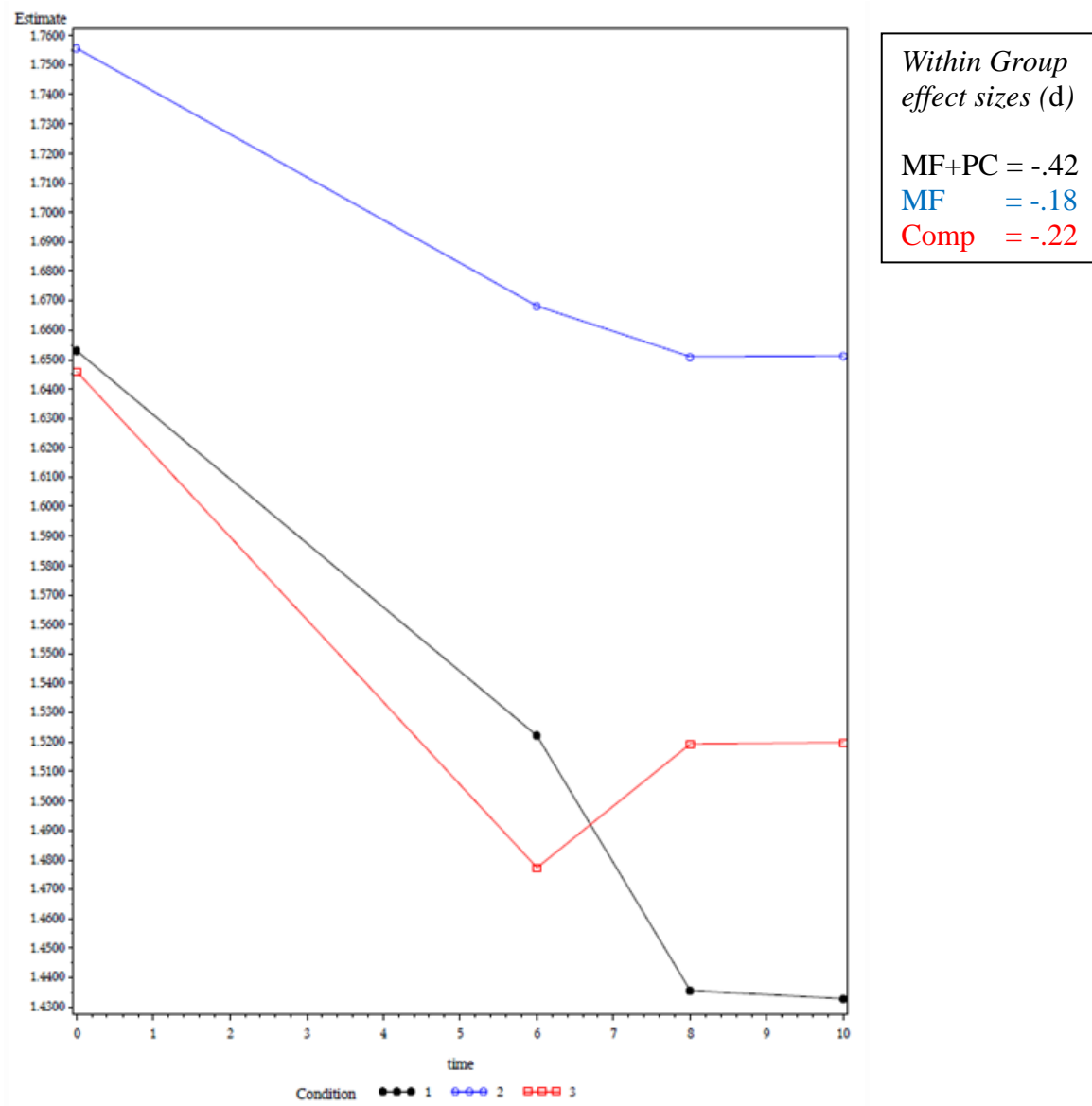
Figure 7. Intervention Effects on Depression

Note. 1=Mindfulness plus Present Control, 2=Mindfulness Only, 3=Comparison Group. Within-group effect sizes are from preintervention to 2nd follow-up.

Figure 8. Intervention Effects on Perceived Stress

Note. 1=Mindfulness plus Present Control, 2=Mindfulness Only, 3=Comparison Group. Within-group effect sizes are from preintervention to 2nd follow-up.
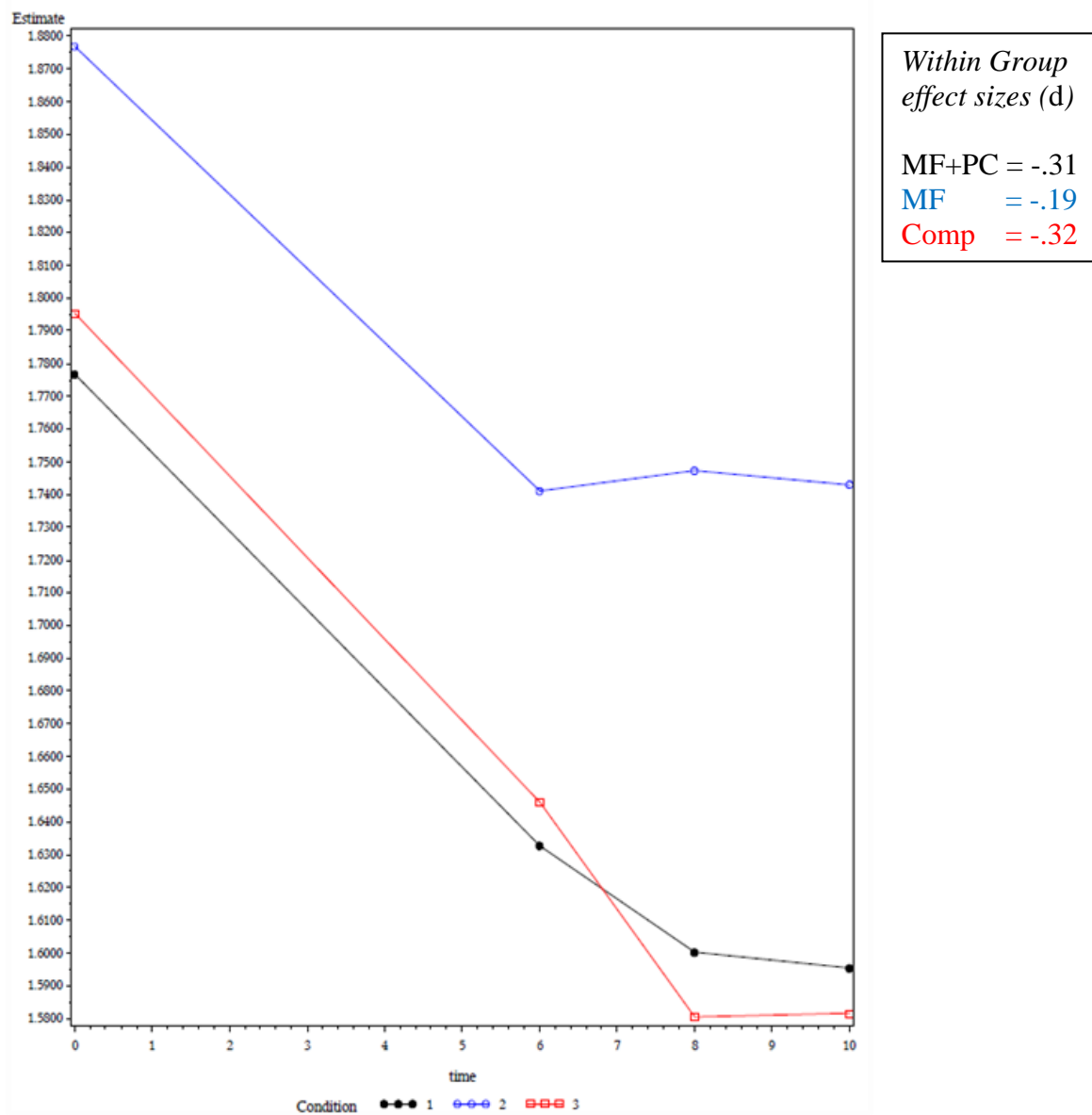
Figure 9. Intervention Effects on Worry

Note. 1=Mindfulness plus Present Control, 2=Mindfulness Only, 3=Comparison Group.
Within-group effect sizes are from preintervention to 2ⁿᵈ follow-up.

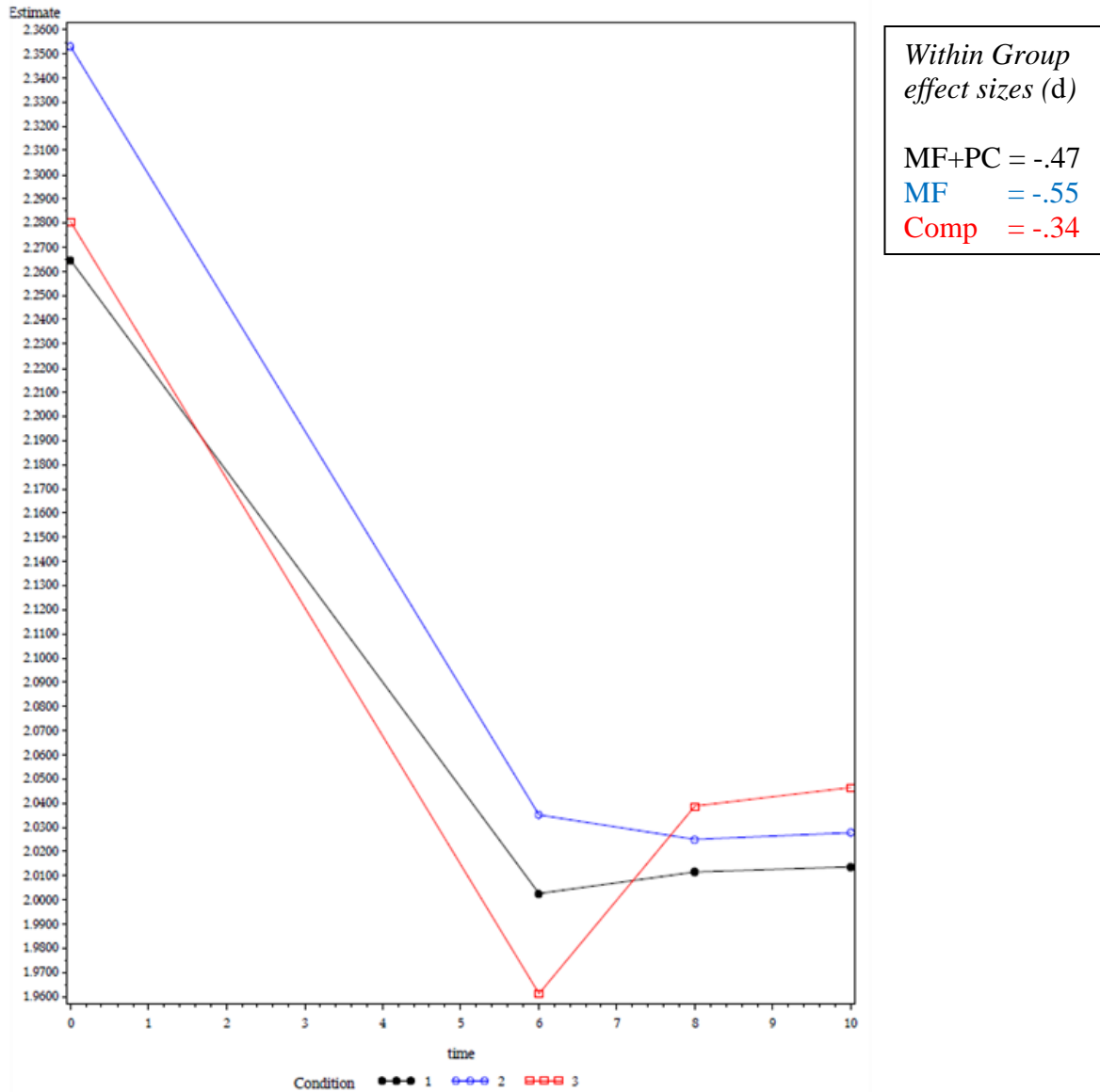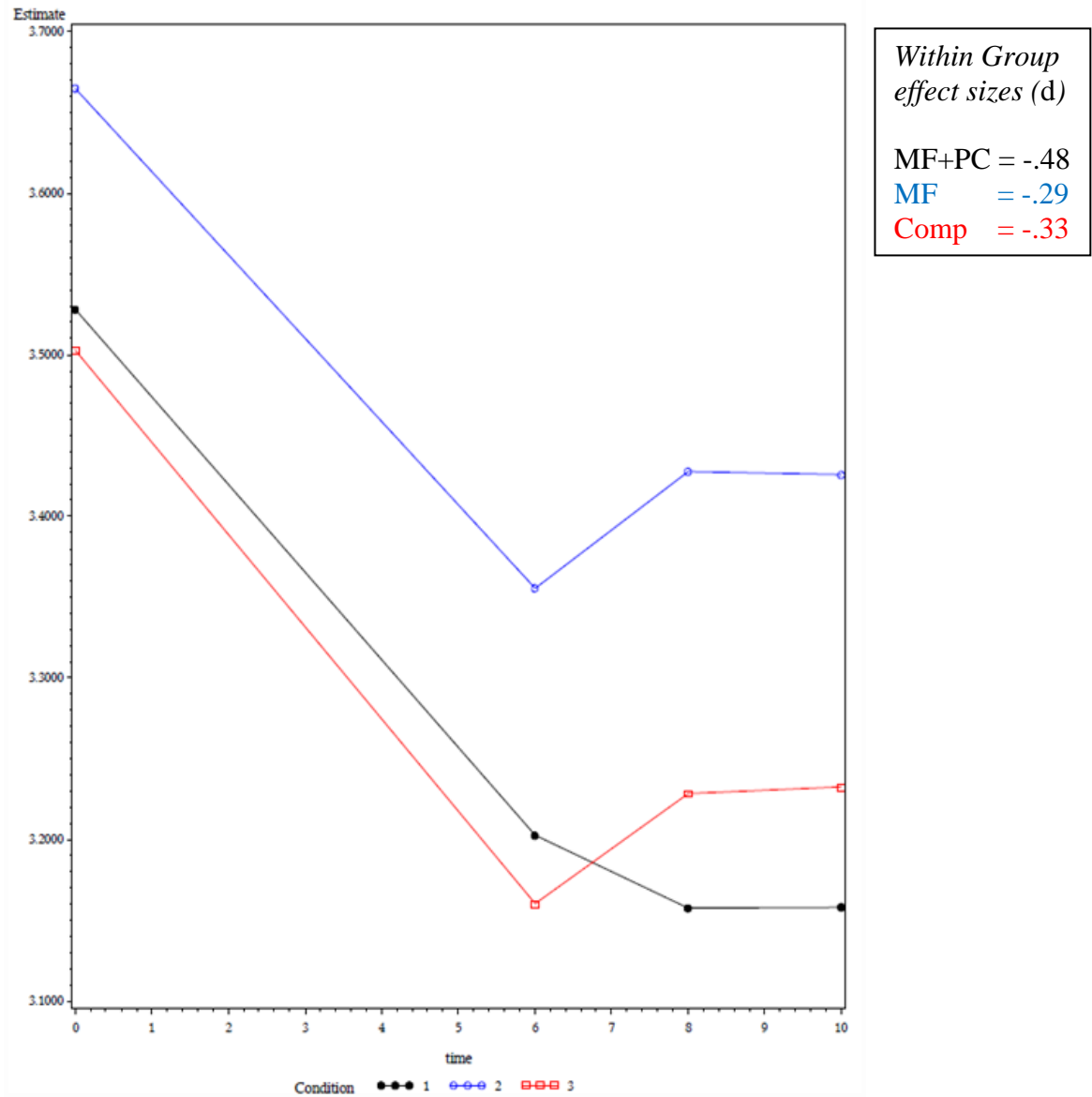*Note. 1=Mindfulness plus Present Control, 2=Mindfulness Only, 3=Comparison Group. Within-group effect sizes are from preintervention to 2nd follow-up.*

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Appendix A: Prevalence of Stress in College

The authors of the College Student Health Survey Report randomly selected 10 Minnesota colleges and universities and gathered data from over 6,000 students. The authors found that 44% of students reported experiencing two or more stressors from a list of 19 in the past year while 23% reported experiencing three or more stressors (Lust & Golden, 2012). The types of stressors endorsed related to health, financial, interpersonal and academic concerns including illness, debt, relationship difficulties and failing a class, respectively. Overall, 26% were unable to manage their stress effectively. Prior iterations of the survey looking at different Midwestern schools found similar prevalence rates so the experience of stress on campus is, in some samples, consistent over time (Lust, Ehlinger, & Golden, 2011; 2010, 2009). However, there is some evidence that today's students encounter more stress than students from earlier cohorts. Sax (2003) found that students' reports of being "frequently overwhelmed" increased from 16% in 1985 to 27% in 2002. It also is likely that the experience of college adds additional academic, financial and interpersonal stresses beyond that experienced by adolescents in high school as normative data for incoming college freshman demonstrated only 30% reported feeling "overwhelmed by all I had to do" in their senior year of high school (Pryor et al., 2012).

It is not only American college students who experience stress. Though there are not complete data available from countries around the world, evidence form Jordan revealed that 58% of students reported moderate degrees of stress and 17% reported severe levels, which is similar to rates in the US (Hamaideh, 2012). Research from

Turkey found lower levels than in the US with only 20% of undergraduates reporting that they were moderately stressed (Bayrum & Bilgel, 2007). Wong et al. (2006) surveyed 7,000 students in Hong Kong and found 27% reported either moderate or severe stress. Although there is no doubt considerable cultural variability from country to country, it is evident that a significant proportion of college students around the world report experiencing moderate to severe levels of stress, sometimes at rates similar to Americans and sometimes less so. Additionally, the discrepancy in the reported prevalence of stress around the world compared to the US could be due to varying definitions of stress. For instance, Hamaideh (2012) asked respondents to characterize stress as 'pressures', 'conflicts', 'changes' and 'frustrations' whereas American researchers (e.g. ACHANCHA, 2012; Lust & Golden, 2012) enumerated specific stressors such as 'failing a class', 'being arrested' and 'death of someone close to you' as a way to quantitatively assess student experience of stress. These definitional differences in addition to national variation may also account for cross-cultural disparities in stress prevalence.

Appendix B: Effects of Stress on Physical and Mental Health

One study of college graduates found similar associations between life stress and poorer mental health. Here, researchers looked at the relationship between negative social exchanges and life hassles--a measure of chronic stress—and a broad measure of anxiety and depression and found that negative social exchanges correlated .19 with poorer mental health and life hassles correlated .31 (Edwards, Hershberger, Russell & Markert, 2010).

There is some evidence that it is not just the experience of stress, but the extent to which that stress is managed, that leads to psychopathology. Lust and Golden (2012) found an association between unmanaged stress levels and higher rates of diagnosis of both acute and chronic mental health conditions. Specifically, 20% of students with unmanaged stress levels reported a diagnosis of anxiety within the past year compared to 7% of students who considered their stress managed and under control. However, other research seems to contradict these findings. A study of 1,257 university students found that perceived stress was the strongest correlate of mental health, irrespective of level of adjustment, internal resources or social support (Bovier, Chamot, & Perneger, 2004). The authors emphasized that, even in students who had high self-esteem and a sense of mastery or control over their life, and even among students who felt they could turn to families and friends for help in facing difficult circumstances, stress severity still significantly related to poorer mental health. In other words, regardless of how stress was 'managed', it still was associated with negative outcome.

Stress is also likely to impact mental health via more indirect pathways. For instance, stress is negatively associated with general life satisfaction (Weinstien & Laverghetta, 2009) and students with high levels of stress also see themselves as less healthy and have lower self-esteem than their less-stressed peers (Hudd et al., 2000). Additionally, students who experience more stress report less self-efficacy which in turn robustly predicts lower GPA, overall lower levels of persistence and higher attrition, especially for immigrant and minority university students (Zajacova, Lynch & Espenshade, 2005). Other data support the link between stress and poorer performance in school with 19% of college students in one sample reporting that stress resulted in a lower exam grade, and 9% reporting that stress resulted in a lower course grade (ACHANCHA, 2012). Whether looking at survey or neurobiological data it's clear that stress plays an important role in the development of psychopathology and other forms of dysfunction that can interfere with university students' lives.

Physical Health

There is an abundant literature detailing the many deleterious effects stress and other negative mood states have on physical health. Although the normal stress response is often adaptive and motivates animals and humans alike to alter behavior appropriately in order to survive, chronic stress promotes 'wear and tear' on the brain and nervous system that can result in maladaptive changes in physiology and behavior that contribute to poor physical health (McEwen, 2008). Dubbed by McEwen as "allostatic overload", this maladaptive physiological response to stress is characterized by changes in human neural, cardiovascular, autonomic, immune and metabolic systems. Allostatic overload

has been shown to increase one's likelihood for developing cardiovascular disease as well

as reduced functioning of the immune system (Neylon et al., 2013; Salovey, Rothman,

Detweiler & Steward, 2000). In fact, people experiencing severe stressors for longer than

a month have been found to be more susceptible to experimentally-induced colds (Cohen

et al., 1998). This over-activation of the stress pathways in the nervous system and in the

brain is also associated with behavioral changes in humans including increased risk of

smoking, eating too much, drinking alcohol, using drugs and interrupted sleep patterns

(McEwen, 2008).

Turning more precisely to college students, there is ample evidence that stress

negatively affects their physical health too. Edwards et al. (2010) discovered that chronic

stress in university students was related to physical health symptoms ($r = .40$) including

nausea, racing heart, headaches and many others as well as increased visits to the doctor.

Moreover, stress can also affect student behavior which can then have an adverse effect

on physical health. For instance, stress was associated with unhealthy food consumption

(soda, candy, etc…), a reduction in healthy food consumption (e.g., fruits and

vegetables), and reduced exercise and sleep (Hudd et al., 2000). Other research revealed

that students who experienced 3 or more stressors were more likely to engage in

unhealthy behaviors across all domains assessed including tobacco use in the last 30

days, binge drinking in the last 2 weeks, marijuana use in the last 30 days, high credit

card debt in the last month and any gambling in the past 12 months (Lust & Golden,

2012). Consequently, students who experience stress are more likely to suffer from

negative physical outcomes, less likely to engage in healthy eating and exercise, and

more likely to engage in risky behavior that can potentially jeopardize their physical

health.

Appendix C: Empirical Evidence Supporting IBIs for the Treatment of Stress

Day, McGrath and Wojtowicz (2013) evaluated the efficacy, via an RCT, of a six week, internet-based guided self-help program for anxiety, depression and stress in university students (N=66). The intervention implemented cognitive-behavioral principles and included five modules that provided psychoeducation and exercises designed to help students identify thoughts, feelings and behaviors as well as the relationships among them. Each module was organized as a multimedia workbook that included videos, audio files, pictures and activities. Students were asked to identify inaccurate thoughts and were provided online worksheets to challenge them. The authors found the intervention to be effective overall when compared to a wait-list control group. Reliable Change Index scores were calculated and, in the intervention group, 67% (n=22) of participants demonstrated a reliable reduction in depression symptoms, 79% (n=26) showed a reliable reduction in anxiety symptoms and 52% (n = 17) showed a reduction in stress symptoms. Effect sizes for group by time interactions were medium to large for depression (*eta squared*=.07), anxiety (*eta squared*=.08) and stress (*eta squared*=.12). Post-hoc analyses, corrected for multiple comparisons, showed that depression, anxiety and stress scores remained unchanged for participants 6 months post-intervention.

Orbach, Lindsay, and Grey (2007) evaluated an IBI to reduce test anxiety among university students (N=90) using CBT principles. Six modules in length and spanning a 6-week timeframe, the intervention provided psychoeducation on the relationship between stress and test performance as well as exercises meant to challenge irrational thinking and promote an increase in self-relaxation skills. The control group received

four modules with somewhat similar initial content (e.g., the same psychoeducation

module on basic test anxiety). The primary difference between the two groups was the

extent to which instructions about how to relax and focus attention were made explicit.

The control intervention at the end featured online 'brain puzzles' for participants to

solve, while the treatment group worked on identifying and challenging negative

thinking. Assessments were conducted at pre-test and 6 weeks later at post-test. A

separate measure of anxiety not used in either the pre- or post-test was assessed four

months later at follow-up. The authors found that, at post-test, there was a significant

time by group interaction effect but no main effect of group on test anxiety, their primary

outcome. The authors concluded that, though the participants in the control group, who

listened to relaxing music and wrote down their thoughts in a journal improved, there was

greater improvement in the treatment group. Indeed, effect sizes showed a between-group

effect size of $d = .88$ for the intervention on overall test anxiety. The authors also

concluded that, aAt post-test, 53% of students in the CBT group demonstrated clinically

significant improvement compared to 29% in the control group. At four month follow-

up, the authors administered a measure to assess test anxiety retrospectively, before and

after the intervention. By this point, participants in the control group had the chance to

use the intervention as well. The authors reported that, for all participants, there was a

significant difference between anxiety recalled before and after the intervention ($d = 2.8$).

This score should be regarded skeptically though as the authors had the participants

retroactively assess their anxiety instead of actually assessing it at follow-up using the

same measures employed at both pre- and post-test.

Another study (N=63) of participants recruited online (with a mean age of 40)

assessed the effectiveness of an online intervention to promote time management,

problem solving and relaxation; the authors found that the intervention group had

significantly greater reductions in stress than the wait-list control group (Zetterqvist,

Maanmies, Strom & Andersson, 2003). This IBI was composed of six modules that

focused on the aforementioned coping skills with a homework component as well. Data

were collected pre-intervention in "late April" and post-intervention subsequently during

"June/July". Results post-intervention indicated that though both groups showed a

decrease in perceived stress, anxiety and depression symptoms, the active condition

decreased significantly more than the control with between-group effect sizes of $d = .62$

on perceived stress, and $d = .60$ on anxiety and depression symptoms Notably, the authors

found considerable attrition. On average, participants completed 4 out of 6 modules with

12 subjects completing all the homework. Interestingly, the intervention was effective

despite that the majority of participants did not complete it as assigned.

Related Conditions

IBI's have been used to treat psychological problems other than university stress.

Panic and Anxiety

Amstadter, Broman-Fulks, Zinzow, Ruggiero, and Cercone (2009) reviewed nine

IBIs for the treatment of Panic Disorder and found that they were more effective in

treating symptoms than either psychoeducation or wait-list controls. In some cases, IBIs

were as effective as face-to-face counseling, in others they were less effective. Still, the

authors reported moderate to large within-group effect sizes for interventions that were

primarily based on CBT exercises and theory both at post-treatment and at follow-up, which varied from one week to a year. Similarly, a meta-analysis of IBIs found them effective for treating panic and anxiety symptoms with an overall effect size of .80 across 23 different studies (Barak, Hen, Boniel-Nissim, & Shapira, 2008). Finally, another meta-analysis of 23 RCTs investigating computer-aided psychotherapy (CP) for the treatment of anxiety disorders found an overall mean effect size of 1.08 when comparing CP to control conditions (Cuijpers et al., 2009). Interestingly, when compared to face-to-face psychotherapy (13 comparisons examined), CP did not differ significantly in effectiveness.

Depression

Eight of ten RCTs assessing the effectiveness of IBIs for the treatment of depression found them to reduce related symptoms (Amstadter et al., 2009). Results were comparable to Barak et al's. (2008) effect size calculation for 16 different online treatments for depression (d=.32). The most recent and comprehensive meta-analytic review examined 19 RCTs revealing a moderate post-treatment pooled between-group effect size of d=.56 for IBIs designed to treat depression (Richards & Richardson, 2012). Another meta-analysis of computer-based interventions for depression found similar results, with an average effect size of .40 relative to control conditions (Cuijpers, 2007). Notably, Griffiths et al. (2004) found that their IBI reduced feelings of stigma relative to the control condition. Additionally, Selmi and colleagues (1990) compared computer-based CBT with therapist-administered CBT and found that both conditions were superior to the wait-list control but detected no differences between the computer- and

therapist-administered CBT groups. Interestingly, a group of researchers found their skills-based training program to treat depression to be ineffective despite being adequately powered (Clarke et al., 2002). However, the authors determined that few participants used the website they created. As such, in a second trial, the researchers sent reminders to participants in the IBI condition. This second RCT was then found to be effective, perhaps indicating that IBIs are more effective when participants are reminded to use them (Clarke et al, 2005). The authors interpreted the findings differently, concluding that there was tentative evidence that interventions with a higher intensity or ones administered with greater frequency were more likely to be effective.

To summarize, most of the interventions shared some common components. Most of the IBIs reviewed were adapted from CBT and included psychoeducation, cognitive restructuring and exposure (Amstadter et al., 2009). There may be common mechanisms of change within these different IBIs but more research is necessary to identify them. Many of the interventions reviewed were as effective as face-to-face therapy and offered advantages, such as increased privacy and accessibility that traditional counseling cannot.

Appendix D: Mindfulness and Empirical Support for Mindfulness Interventions

Differences in Conceptualizations of Mindfulness in the East and the West

The ability to be mindful is cultivated through meditative practices that have their origins in Buddhist spiritual traditions, but it was not until the late 1970s that Western medical and mental health practitioners began to incorporate mindful meditation as a treatment for psychological disorders (Kabat-Zinn, 1982). Keng and colleagues (2011) believe that to fully appreciate how Buddhist traditions influence Western psychotherapy it is important to distinguish how Western mindfulness differs from its Eastern progenitor in context, process and content. Contextually, mindfulness in Buddhism is part of an interconnected set of practices, including living an ethical existence, that is supposed to lead to liberation from suffering. However, western conceptualizations of mindfulness are independent and ignore Buddhism's associated philosophical, lifestyle and ethical practices. Moreover, western applications of mindfulness do not emphasize the same practices seen in Buddhism, like the study of texts that suggest Buddhist practitioners observe the impermanence of reality or the concept of the non-self (the belief that the universe is essentially connected and that substantive differences between objects within it are illusory). Lastly, Buddhist traditions exhort followers to focus more on their internal cognitions and feelings whereas western implementations of mindfulness often focus both on internal sensations as well as external stimuli (Keng, Smoski, & Robins, 2011).

Though meditation was studied in various ways throughout the 1960s and 1970s, it was not until Jon Kabat-Zinn explored using mindful meditation to treat chronic pain using what is now known as Mindfulness-Based Stress Reduction (Kabat-Zinn, 1982) that the practice was used to address psychological and physiological well-being. Since then, mindfulness-based principles have been employed by various researchers and clinicians in the form of Mindfulness-Based Cognitive Therapy (Segal, Williams & Teasdale, 2002), Dialectical Behavior Therapy (Linehan, 1993) and Acceptance and Commitment Therapy (Hayes, Strosahl & Wilson, 1999).

Empirical Support for Mindfulness Interventions

There are a variety of different forms of both meditation and mindfulness-based psychological interventions. For the purposes of this brief review, this paper will review the dominant and most used forms of mindful interventions: mindful meditation, Mindfulness-Based Stress Reduction (MBSR), Mindfulness-Based Cognitive Therapy (MBCT), Dialectical Behavior Therapy (DBT) and Acceptance and Commitment Therapy (ACT). Lastly, the paper will examine the effectiveness of mindfulness interventions adapted for the internet, and mechanisms of change.

Correlates of Mindful Meditation

Correlational studies have found that the practice of meditation is associated with a plethora of positive psychological outcomes. Specifically, one study compared meditators and non-meditators on several measures of psychological well-being and found that meditators reported higher levels of mindfulness, self-compassion and overall sense of well-being and significantly lower levels of rumination, thought suppression,

fear of emotion and emotional dysregulation (Lykins & Baer, 2009). Higher scores on

these variables were linearly associated with the amount of time practitioners meditated.

Baer et al. (2008) found evidence that trait mindfulness mediated the relationship

between the amount of meditation practice and various measures of psychological well-

being including rumination and behavioral self-regulation.

Mindfulness-Based Stress Reduction (MBSR)

MBSR was developed originally as a group treatment for chronic pain, but has

since been used to treat numerous psychological disorders and symptoms (Kabat-Zinn,

1990). The program includes intensive training to help participants relate to their

thoughts and feelings in an accepting and nonjudgmental way. The program takes eight to

ten weeks during which time up to 30 individuals meet for two hours per week of

mindfulness meditation training (Kabat-Zinn, 1990). In addition to the in-class mindful

meditation, participants are encouraged to use mindfulness practice regularly at home and

to attend an all-day mindfulness retreat. Many studies, some of them true randomized

controlled trials (RCTs) and many quasi-experimental, have been conducted both with

clinical and non-clinical populations. Overall, there is evidence that MBSR is effective in

reducing self-reported levels of anxiety (Anderson et al., 2007; Ramel et al., 2004),

depression (Grossman et al., 2010), anger (Anderson et al., 2007), rumination (Jain et al.,

2007; Ramel et al., 2004) and perceived stress (Oman et al, 2008; Shapiro et al, 2005).

MBSR was also found to increase positive affect (Nyklicek & Kuipers, 2008), empathy

(Shapiro et al., 1998), forgiveness (Oman et al., 2008), self-compassion (Shapiro et al.,

2005) and general life satisfaction (Grossman et al., 2010). Despite an emerging

empirical foundation, future research is needed to further substantiate MBSR's

effectiveness as many of the studies reviewed lacked adequate designs (e.g., lack of

control condition) or had poor outcome measures (Hoffman, Sawyer, Witt & Oh, 2010).

For example, a meta-analysis reviewed 64 different MBSR studies but only found 20 that

were properly designed, used appropriate measures, and had adequate statistical analyses

(Grossman, Niemann, Schmidt & Walach, 2004). Of those 20, only 7 were truly

experimental studies with random assignment and 3 were quasi-experimental. Ultimately,

the authors determined MBSR to have a within-group effect size of $d = .50$ on depression

and anxiety symptoms.

Mindfulness Based Cognitive Therapy (MBCT)

MBCT, a manualized eight-week group intervention, was adapted from the

MBSR model (Segal et al., 2002). It was originally created to prevent relapse in

depression. It weds mindfulness training with aspects of cognitive therapy (CT) to help

participants see thoughts as events instead of truths, to identify and recognize the role of

negative automatic thoughts as responsible for maintaining depression, and to learn how

to detach from those same thoughts. Teasdale, Segal, and Williams (1995) argued that

negative thoughts become associated with depressed states and that, as the number of

depressive episodes increase, negative automatic thoughts are more easily activated by

negative feelings. The negative thoughts, in turn, are thought to increase the likelihood of

relapse into depression. MBCT is effective in preventing relapse for patients with three or

more episodes of depression but not for those with fewer episodes (Ma & Teasdale,

2004). These findings have been replicated by others (Bondolfi et al., 2010; Godfrin &

van Heeringen, 2010). Moreover, MBCT was found to ameliorate a number of depressive symptoms and improve overall quality of life (Godfrin & van Heeringen, 2010; Kuyken et al., 2008). Among patients who are currently depressed, MBCT is more effective than treatment as usual (TAU) in reducing depressive symptoms (Barnhofer et al., 2009). However, more research is needed to further validate and replicate the preliminary findings that MBCT is effective in preventing relapse into depression and treating current depression.

Dialectical Behavior Therapy (DBT)

DBT was created by Marsha Linehan (1993) to treat the emotional dysregulation, self-injurious behaviors and chronic suicidality associated with borderline personality disorder (BPD). DBT incorporates elements of mindfulness with conventional CBT and combines acceptance and attempts to change behavior to help patients reduce emotional reactivity. Treatment includes individual therapy, group emotional regulation training, telephone counseling and group consultation for the therapist. Participants are taught mindfulness skills through various exercises that focus on improving distress tolerance as well as interpersonal skills. Several RCTs have been conducted to evaluate the effectiveness of DBT. These studies have found DBT to be superior to TAU for reducing severity and frequency of suicidal behaviors which in turn reduced the number of hospitalizations, psychiatric admissions and emergency room visits (Linehan et al., 2006; Verheul et al., 2003). DBT was also found to be effective in reducing substance use disorders (Linehan et al., 1999, 2002) as well as improving overall functioning and social interactions at 2-year follow-up (Linehan et al., 2006).

Acceptance and Commitment Therapy (ACT)

ACT was developed by Hayes and colleagues (1999) to treat a variety of psychological problems. The central belief in ACT is that avoidance of unpleasant cognitions and emotions leads, paradoxically, to increased frequency and severity of the avoided internal experiences. As such, the primary aim of ACT is to increase the individual's ability to accept negative internal experiences, and commit to behaving in a way congruent with the person's values regardless of the emotional or cognitive consequence. The treatment consists of helping participants accept their internal experiences, separate themselves from them, make sustained contact with the present moment, see the self in context, and explore values and commit to action congruent with those values (Hayes, Luoma, Bond, Masuda, & Lillis, 2006). There is no mindful meditation in ACT per se, but many of the exercises intended to promote the above processes cultivate self-awareness and a non-judgmental attitude that are at the heart of mindfulness interventions. There is substantial variation in how ACT is delivered, with some interventions lasting a day and others up to four months. ACT has been found to be more effective than TAU in reducing negative affect and improving interpersonal functioning (Bach & Hayes, 2002). ACT has also been found to be more effective than no treatment, as effective as other interventions (e.g. cognitive therapy), and sometimes more effective than other interventions (e.g. CBT) in reducing depression, anxiety and other negative psychological outcomes like re-hospitalizations (Bond & Bunce, 2000; Forman et al., 2007; Gaudiano & Herbert 2006; Zettle, 2003). ACT was also effective in

reducing substance use among smokers (Gifford et al., 2004) and poly-substance opiate

addicts (Hayes et al., 2003).

Appendix E: Empirical Evidence Supporting Mindfulness IBIs

Directly relevant to the purposes of the current study, several mindfulness-based online interventions have already been created and evaluated. Morledge et al. (2013) developed an 8-week internet-based stress management program incorporating many mindfulness elements. Participants (N=703) were randomized into one of three conditions: control, the mindfulness stress intervention, or the mindfulness stress intervention plus access to an online message board where participants could share their experiences using the intervention with one another. A 'message board leader', presumably a member of the research team, posted discussion threads on the board to create interest in the program and generate conversation. The leader did not provide any feedback or advice. For each of the 8 weeks, a new meditation theme was introduced to develop various mindfulness skills including focusing on the breath, learning how to do a body-scan, guided imagery, and how to cultivate compassion and kindness in daily life. Each theme followed the same structure. First, participants received instructions on each concept via web page views or a 5-10 minute audio clip. Second, weekly guided meditation (20 minutes long) were embedded in the web site and could be downloaded. Participants were encouraged to listen to the recording five times per week and to record their mindfulness practice. Third, the website featured daily articles providing the scientific rationale and evidence to support the intervention's efficacy. Finally, each week daily tips suggesting how to incorporate mindfulness into daily activities and motivational quotes were posted to the website. Participants were sent twice weekly

emails to remind them to practice. The control group received no intervention and were

offered the mindfulness intervention following completion of the study.

Of the 551 participants who completed the baseline questionnaire, 57% completed

one or both follow up questionnaires (n=312). The intervention completion rates also

varied by treatment group: 41% completed the standard intervention, 44% completed the

intervention plus message board, and 67% completed activities in the control group

(these activities were not specified, presumably they were psychoeducational in nature).

Using linear mixed modeling, statistical analyses indicated significant between-

group differences in change from baseline scores for each of the intervention conditions

compared with the control condition at the end of the program and at one month follow-

Of the 15 dependent variables assessed, this paper will evaluate those relevant to mental

health, including perceived stress, psychological well-being and self-acceptance, and

overall mental health.

As there were no significant differences between the two intervention groups, for

the sake of brevity this paper will report relevant results calculated from the standard

intervention only. Using the intent-to-treat data from the linear mixed model analyses, the

within-group effect size from pre-test to follow-up was $d = .89$ for the standard

intervention group and the between-group effect size was $d = .48$ for the standard

intervention versus the control group on perceived stress. For psychological well-being

and self-acceptance, the within-group effect size from pre-test to follow-up was $d = .36$

and the between-group effect size was $d = .20$ for the standard intervention versus the

control group. For overall mental health, the within-group effect size from pre-test to

follow-up was $d = .50$ and the between-group effect size was $d = .26$ for the standard intervention versus the control group.

The results on perceived stress and overall mental health were clinically meaningful according to two common clinically important difference (CID) criteria: change of more than 10% of the score range and .50 baseline standard deviations within-group change (Ringash, O'Sullivan, Bezjak & Relmeier, 2007). The sample had an initially high baseline stress score, probably because many were referred by physicians whose patients were struggling with stress, but on average the intervention groups were able to bring down stress levels to a normal range. Results were comparable to face-to-face mindfulness interventions (e.g., $d = .50$; Grossman et al., 2004) with participants who were similarly engaged for 6-8 weeks.

Another study (N=100) assessed the effectiveness and feasibility of an 8-week online mindfulness intervention based on MBSR and MBCT course content (Krusche, Cyhlarova, King & Williams, 2012). The course taught participants how to use meditation and mindfulness skills via audio and video clips embedded in a website. Participants were also assigned homework logs to track how often they completed various mindfulness activities during the week. Weekly email reminders were sent to participants to encourage them to complete at least four weeks of content. Results indicated a large reduction in perceived stress from pre- to post-intervention (d=1.57) that was maintained at one month follow-up. The authors divided their sample into three groups according to the amount of practice reported by participants: high (every day), medium (sometimes) and low (rarely). Interestingly, there were no significant differences

between these three groups, though participants in the high group had significantly higher baseline stress scores than the other groups. A significant limitation to the study was the lack of a control group. As such, reductions in perceived stress cannot be linked directly to the mindfulness intervention.

Perhaps the most relevant of the mindfulness-based IBIs reviewed, Cavanagh et al. (2013) evaluated via an RCT a two week, self-guided, online intervention designed to reduce perceived stress and anxiety/depression symptoms within a university student population in comparison to a wait-list group. Developed and administered using the University of Sussex's learning management system, Moodle, the psychoeducational content consisted of information about mindfulness and mindful meditation as well as audio-based guided meditation. The program was comprised of five different sections that used text and video to explain the origins and benefits of mindfulness, a selection of guided meditations along with instructions, and a daily journal where participants could reflect on their mindful practice. The last two sections were administrative in content (e.g., contact emails for study supervisors, troubleshooting advice for the website). Participants had the choice to listen to either a male or female voice reciting the various guided meditations. The intervention group (n = 54) was compared to a delayed access control group (n = 50). The control group received the intervention prior to follow-up which occurred 6 months after the 6-week long intervention was completed. Participants also received standardized emails reminding them at 3-day intervals to complete their daily tasks.

At post-intervention assessment, there was an 80% completion rate (12 participants dropped out, 9 from the intervention group and 3 from the control group). Overall, only 34% of participants (24 subjects) completed 6-month follow-up however, making it unlikely the study was adequately powered. Results showed significant group by time interactions at post-test for perceived stress and symptoms of depression and anxiety. For perceived stress, simple contrasts showed that, whereas scores for the wait-list group remained unchanged, there was a significant decrease in perceived stress for the intervention group (within-group $d = .37$). Similarly, there was a significant group by time interaction for anxiety and depression symptoms. Simple contrasts showed that scores on the wait-list group remained unchanged while there was a significant decrease in anxiety and depression symptoms for the intervention group (within-group $d = .24$).

Appendix F: Two Pilot Study Effect Size Tables

Table 11

Within Group and Between Group Effect Sizes for 1st Pilot Study, Cohorts 1B and 2 combined (Cohen's d)

		Within Group d	Between Group d		
Variable	Group	T1-T2	1v2	2v3	1v3
Depression	1	.02	.43	.21	.22
	2	.45			
	3	.24			
Anxiety	1	.04	.22	.05	.17
	2	.26			
	3	.21			
Stress	1	.02	.24	.06	.30
	2	.26			
	3	.32			
Perceived Stress	1	.18	.35	.11	.24
	2	.53			
	3	.42			
Rumination	1	.07	.21	.06	.27
	2	.28			
	3	.34			
Positive Affect	1	.10	.11	.04	.15
	2	.21			
	3	.25			
Negative Affect	1	.03	.16	.18	.34
	2	.19			
	3	.37			
Worry	1	.12	.32	.11	.21
	2	.44			
	3	.33			
Non-reactivity	1	.58	.25	.00	.25
	2	.33			
	3	.33			
Present Control	1	.16	.42	.10	.50
	2	.58			
	3	.68			

Note. T1 = Time 1. T2 = Time 2. Group 1 = Present Control Intervention (n = 101), Group 2 = Enhanced Stress Logs (n = 104), Group 3 = Mindfulness Intervention (n = 103). Within group *d*'s were calculated by subtracting the mean of each group at T2 from the mean of that group at T1 and dividing by the SD of that group at T1 as recommended by Morris and DeShon (2002). The between-group *d* is then the difference between these two within-group effect sizes.

Table 12

Within Group and Between Group Effect Sizes for 2nd Pilot Study (Cohen's d)

		Within Group d	Between Group d		
Variable	Group	T1-T3	1v2	2v3	1v3
Depression	1	.16	.27	.11	.38
	2	.43			
	3	.54			
Anxiety	1	.46	.01	.16	.17
	2	.45			
	3	.29			
Stress	1	.42	.24	.12	.12
	2	.66			
	3	.54			
Perceived Stress	1	.48	.02	.01	.01
	2	.50			
	3	.49			
Rumination	1	.59	.17	.20	.37
	2	.76			
	3	.96			
Present Control	1	.62	.02	.29	.27
	2	.64			
	3	.35			

Note. T1 = Time 1. T2 = Time 2. Group 1 = Present Control Intervention (n = 70), Group 2 = Enhanced Stress Logs (n = 70), Group 3 = Mindfulness Intervention (n = 73). Within group *d*'s were calculated by subtracting the mean of each group at T2 from the mean of that group at T1 and dividing by the SD of that group at T1 as recommended by Morris and DeShon (2002). The between-group *d* is then the difference between these two within-group effect sizes.

Appendix G: Psychoeducational Worksheets Used in Comparison Group

Week 1:

http://www.sass.umn.edu/pdfs/IV%20Life%20Balance/Stress%20Management/Managin
g%20Stress/C%204.12.3%20Tips%20for%20Stress%20Management.pdf

http://www.sass.umn.edu/pdfs/IV%20Life%20Balance/Stress%20Management/Managin
g%20Stress/C%204.12.4%20%20Positive%20Side%20of%20Stress.pdf

Week 2:

http://www.sass.umn.edu/pdfs/IV%20Life%20Balance/Stress%20Management/Managin
g%20Stress/C%204.12.17%20Getting%20a%20handle%20on%20stress.pdf

http://www.sass.umn.edu/pdfs/IV%20Life%20Balance/Stress%20Management/Managin
g%20Stress/C%204.12.18%20101%20Strategies%20Stress%20Coping.pdf

Week 3:

http://www.sass.umn.edu/pdfs/IV%20Life%20Balance/Stress%20Management/Managin
g%20Stress/Small%20Ways%20to%20manage%20big%20stress.pdf

http://www.sass.umn.edu/pdfs/IV%20Life%20Balance/Stress%20Management/Stress%2
0Assessment/C%204.12.9%20How%20Vulnerable%20Are%20You%20to%20Stress.pdf

Week 4:

http://www.sass.umn.edu/pdfs/IV%20Life%20Balance/Stress%20Management/Stress%2
0Assessment/C%204.12.7%20Distress%20Symptoms%20or%20Signals.pdf

http://www.sass.umn.edu/pdfs/IV%20Life%20Balance/Stress%20Management/Stress%2

0Assessment/C%204.12.10%20Detecting%20the%20Type%20A%20Behavior%20Patter

n.pdf

Appendix H: Summary Tables of ANCOVA Analyses

Table 13
Between-group differences from ANCOVA analyses on mediator and outcome variables
at postintervention

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Variable	df	F	P
Present Control	253	0.39	0.68
Mindfulness	254	5.99	0.003
Rumination	251	6.83	0.001
Stress	254	1.95	0.14
Anxiety	254	1.71	0.18
Depression	254	2.84	0.06
Perceived Stress	240	4.31	0.01
Worry	254	2.19	0.12

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Table 14
Between-group differences from ANCOVA analyses on mediator and outcome
variables
at 1st Follow-up

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Variable	df	F	P
Present Control	265	0.35	0.7
Mindfulness	365	3.41	0.04
Rumination	250	.51	0.6
Stress	265	1.91	0.15
Anxiety	265	1.81	0.17
Depression	265	0.3	0.75
Perceived Stress	248	0.14	0.87
Worry	264	0.55	0.58

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Table 15

Between-group differences from ANCOVA analyses on mediator and outcome variables at 2nd Follow-up

Variable	df	F	P
Present Control	238	0.94	0.39
Mindfulness	239	2.01	0.13
Rumination	237	0.2	0.82
Stress	239	2.21	0.11
Anxiety	239	2.2	0.12
Depression	239	1.7	0.19
Perceived Stress	219	0.25	0.78
Worry	237	1.5	0.23