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Two-Week Web-Based Mindfulness Training Reduces Stress, Anxiety, and Depressive Symptoms in Individuals with Self-reported Stress: A Randomized Control Trial

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Abstract

The study examined the effects of a short-term web-based mindfulness program. Participants describing themselves as stressed were recruited and a total of 70 participants were randomly assigned to a treatment group (*n*=35) and a control group (*n*=35). The mindfulness program included two, 10-minute exercises per day, six days a week, for two weeks. Twenty participants in the treatment group and 34 participants in the control group completed the training. The mean pretest scores indicated that the group was above the cutoff for severe stress on a well-established measure (the Perceived Stress Questionnaire). Measures of stress, anxiety and depression symptoms, and a mindfulness questionnaire were administered before, during (after 1 week), and at the end of the treatment (after 2 weeks). The results showed that mindfulness training increased mindfulness skills and reduced levels of perceived stress, anxiety, and depressive symptoms (Cohen's *ds* > 1). No significant changes from pre- to posttest were observed in the wait-list control group. Additionally, increments from pre- to post-test in mindfulness skills were associated with reductions in symptom scores, indicating treatment-specific effects. Together, the results suggest that the brief web-based mindfulness program may serve as an effective means to treat individuals suffering from stress, and motivate further research involving active control groups, alternative forms of web-based treatments as a control, and long-term follow-up of the effects.

Keywords: Mindfulness; Web-based training; Perceived stress; Anxiety; Depressive symptoms

Introduction

Even though stress may be adaptive in the short run, prolonged stress reactions may have adverse effects on many different aspects of physical and mental health [1,2] and on cognitive performance [3]. Thus, the high prevalence of stress-related conditions is of considerable concern both from viewpoint of the burdens on the society they cause (i.e., in terms of health-care costs, costs for sick leave) and from viewpoint of the individuals at risk.

Psychotherapeutic treatment methods, such as forms of cognitive behavioral therapy (CBT) are, apart from to medication, available as tools to reduce stress. In the last decades researchers have attended to the possibility that an alternative, and less resource intensive, method aimed to increase mindfulness, can serve a similar purpose.

Mindfulness may be described as "paying attention in a particular way; on purpose, in the present moment, and nonjudgmentally" [4]. An operational definition of mindfulness involving two components was proposed by Bishop et al. [5]. The first, self-regulation of attention, involves switch attention and inhibit elaborative processing. The second, orientation to experience involves adopting a particular orientation towards the present moment and characterized by curiosity, openness, and acceptance. These attitudes provide a non-elaborative awareness to the experience as well as a decentered, and more insightful, perspective on thoughts and feelings. To the extent that mindfulness requires both control of cognitive processes and the ability to monitor the stream of consciousness it may be regarded as a meta-cognitive process [5].

Regarding the effects of mindfulness-based interventions (MBIs), meta-analytic evidence involving over 200 individual studies [6] revealed effect sizes comparable to those obtained for traditional forms of treatment (CBT or medication). The effects held for comparisons of MBIs with wait-list conditions as well as in active control groups. Additionally, a number of studies targeting particular patient groups for example, cancer patients [7] and patients with more specific forms of distresses such as worry and rumination [8] were supportive of the effectiveness of MBIs.

Whereas there is firm evidence in regard to the beneficial effects of MBIs on stress, anxiety and depressive symptoms, relatively little is known in regard to the dose-response relationship of mindfulness training. The original program by Kabat-Zinn [9] was designed to be sufficient in duration for participants to grasp the principles of self-regulation and to develop skills and autonomy in mindfulness practice. The current standard form [4] involves 26 h of session time over a period of eight weeks. A highly relevant issue is whether shorter MBIs are sufficient to attain a significant reduction of stress and related symptoms of distress.

Apart from a general advantage of brief interventions, Carmody and Baer [10] noted that brief MBIs, if proven effective, may be particularly apt for certain patient groups for which the demands of the standard forms due to circumstances of the condition, may be difficult to follow (e.g. cancer patients, cardio-vascular patients). For other groups (e.g. caregivers) the demands posed by standard form MBIs may represent a strain on an already overcommitted schedule and a reason to decline participation.

Some evidence pertaining to the effects of shorter than standard MBIs is provided by patterns across studies that involved some

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variability with regard to amount of training. Carmody and Baer [10] considered results from 30 studies in which the mean pre- to post-treatment effect was analyzed in relation to the number of in-class hours. The results revealed no relationship between effect size for measures of psychological distress and amount of training. A similar lack of relationship between effect size and treatment dose was observed in the recent meta-analysis by Khoury et al. [6]. Thus, these observations may be taken to indicate that MBIs shorter than the (8-week) standard form (or less intensive training) could have the potentials to be as effective as the standard MBIs.

A few studies have investigated the possibility that effectiveness of short-form MBIs directly. The effects of a brief (4-week) program with a web-based format (that may yield similar effects as face-to-face formats; e.g. Boettcher et al. [11] was investigated by Adele et al. [12]. Their study involved a program of based on ten sessions, guided meditation videos, and automated emails with elements of mindfulness based stress-reduction and mindfulness-based cognitive therapy. The results showed significant decreases in stress, anxiety, and depression in the treatment group. Further reductions of distress were seen at follow-up measurement, one month later. In regard to shortening of standard training format, Gluck and Maercker [13] went even further using a web-based training program that lasted two weeks only. The treatment group, a young adult sample (n=28), showed a trend of moderate, improvements on measures of stress (PSQ; d=0.46) and negative affect ($PANAS^{neg}$; d=0.50). The effects were not statistically significant for the whole group (presumably related to the modest sample size) but a significant treatment effect was evident when the analyses were restricted to participants with a high level of training adherence.

Thus, a couple of studies were quite encouraging in regard to the effects of brief (<5 week) MBIs. On the other hand, a recent study [14] failed to provide good support of a four-week MBI intervention in an adult (working) sample. More specifically, whereas the treatment group showed increased mindfulness skills compared with a wait-list control group, no treatment effects were observed for aspects of psychological health, including measures of well-being, anxiety, and depression.

Given the relatively limited, and somewhat mixed, evidence regarding effects of briefer than standard MBI programs, the objective of the present study was to examine the effectiveness of a two week mindfulness program on symptoms of stress, anxiety, and depression. We chose a web-based format, motivated by the fact that it could have the potential to further (i.e., in addition to a brief format lower the barriers for treatment seeking, and, thus, to reach out to a larger number of people in need of psychological treatment. The study additionally included measurements of mindfulness (pre and post) to examine whether that potential effects of the intervention was related to improved mindfulness skills, rather than some more general treatment factor, a control that was lacking in many MBI studies [6].

Methods

Participants and procedure

Participants were recruited through an advertisement on the Mindfulness center home page on Facebook. The advertisement called for participants who judged themselves as stressed and were interested in participating in a short web-based mindfulness program. One hundred and fourteen participants volunteered. These individuals received a form concerning informed consent and questions concerning physical or psychological disorders. Based on the latter questions, 11 individuals were excluded due to the fact that they reported physical or mental health problems (other than perceived stress). The remaining 103 individuals were requested to fill in web-based forms including measures of stress (the Perceived Stress Questionnaire, PSQ, and the Perceived Stress Scale, PSS), anxiety and depression (the Hospital Anxiety and Depression Scale, HADS) and mindfulness (Five Facets of Mindfulness Scale, FFMQ), described in detail below. Questions were also asked concerning prior experience with mindfulness training. Of the participants, 78 completed the forms in the time allotted. Eight were excluded due to the fact that they reported having practiced mindfulness training during the last three months.

The remaining 70 participants were randomly distributed to treatment and control groups (35 participants in each) that turned out to be comparable in regard to demographic characteristics, including age distribution (most reporting their age to be in the range from 40 to 50 years in both groups), sex (90% were women; n=32 and n=33 respectively in the treatment and control group), and employment rate (a majority, 78.6% being employed, overall).

The participants were sent an email with instruction of further procedures; the participants in the treatment group received details necessary to access the web-based mindfulness program together with detailed instructions concerning the training. The training period lasted two weeks (details pertaining to the program is specified below) with follow-up measurement on the stress (FFMQ, PSS), and an inventory targeting anxiety and depressive symptoms (HADS) after one week, an a post-test including the same measures together with re-administration of the PSQ at the end of the two-week program (PSQ was included mainly due the fact that normative are available; and as the PSS was included as part of all three measurements, it was deemed to be sufficient with a pre- post comparison only for the PSQ). Participants in the control group received no particular treatment during the period but were provided free access to the training program following completion of two-week follow-up measurement (i.e., a wait-list control group was employed).

Intervention

Mindfulness program: The web-based mindfulness program [15] included a video-based instruction explaining the content and goal of the program and a recommendation to train ten minutes, on two occasions, six day per week. The training involved two basic exercises: 1) breathing anchor, and 2) body scan. For each exercise, there were slight alterations (four versions of the breathing anchor and three version of the body scan). Each exercise required 10 min to perform. In the online program the exercises are present auditorially and stepwise, such that a given exercise and step of the program is available only once the foregoing exercise has been completed. The time used for training was registered following the completion of each exercise.

Measures

Five facet mindfulness questionnaire (FFMQ): The FFMQ [16] was developed so as to capture five factors believed to be central to the mindfulness concept: observe, describe, act consciously, a nonjudgmental attitude towards inner experiences, and non-reactivity to inner experience. The original questionnaire consists of 39 items rated on a five-point Likert scale ranging from "never/almost never" (coded as 1) to "most of the time"; a summation score is usually taken to indicate the individual level of mindfulness. The Swedish version of the FFMQ [17], used in the present study, is a revised version of the original scale and contains 29 items, with good internal consistencies for the five subscales (α=0.75-0.85) and for the total scale (α=0.81). Validity evidence for the FFMQ includes associations with meditation

experience, psychological symptoms and measures of well-being [18].

Perceived stress questionnaire (PSQ): A Swedish version [19] of the original PSQ [20] was included as a measure of perceived stress. It consists of 30 statements describing different stress-related experiences ("you feel tense"; "you feel that problems pile up"). The described experiences are rated with regard to frequency of occurrence on a four-point scale: *almost never*, *sometimes*, *often,* and *usually,* coded from 1=*almost never* to 4=*usually,* in accord with Levestein et al. [20]. Two alternative versions, differing only in regard to the instructions, can be used. The first, *PSQ-recent,* involves rating the frequency of occurrence of the described experiences during the past month, and the second, *PSQ-general*, during the last year. In the present study the *PSQ-recent* version was used. A PSQ-index is computed as (raw score-30)/90, resulting in a score ranging from 0 (lowest level of perceived stress) to 1 (highest level of perceived stress), with cut-offs for moderate stress >0.30 and for severe stress >0.45. A Cronbach's α of .90 has been reported for the Swedish version [21].

Perceived stress scale (PSS): A Swedish translation of the Perceived Stress Scale (PSS-14) [22] was used as a second measure of stress. The PSS-14 is a 14-item, self-reported one dimensional instrument developed to measure perceived stress. The included statements which describe situations involving stress are rated on a five-point Likert-scale coded as: 0=Never, 1=Almost never, 2=sometimes, 3=often, and 4=very often. PSS-14 has reliability in test and retest, adequate internal consistency and concurrent and predictive validity [22,23]. Scores of the PSS-14 range from 0 to 56; the higher scores are indicative of more perceived stress. Respondents report the prevalence of an item within the last month, but for purposes of the present study, the instructions were modified so that that the participants were to report the prevalence during the last week.

Hospital anxiety and depression scale (HADS): A Swedish version of the HADS [24] was included to measure aspects of psychological distress. HADS was originally developed by Zigmond and Snaith [25] and is a fourteen item scale. Seven of the items relate to anxiety and seven relate to depression. The scores are summed for the separate scales. Common cutoff values/classifications of scores for the two subscales are usually: 8-11: mild anxiety/depression, 12-14: moderate, and 15 or higher: severe.

Results

In the control group, 34 out 35 of participants completed the (1 and 2 week) follow-up measurements. In the treatment group fifteen of the participants failed to complete the training in the time allotted. Examination of background characteristics revealed similar background characteristics (sex, employment) and initial stress levels for those who completed the training (Pretest PSQ-index=0.49) and those who completed the training (PSQ index=0.56; $t(33)=1.68$, $p=0.10$), though.

Comparison of pre- and post-treatment data

The pre- (1 week) and post-treatment (2 week) scores for the treatment and control group are presented in Table 1, together with effect size estimates (Cohen's *d*) based on Cohen's [26] formula correcting for correlations of pre-post-test scores. The reported values pertain to the pre- *vs.* post-test (i.e., 2 week) comparison (Table 1).

Beginning with the measure of mindfulness (FFMQ), the means in Table 1 reveal a continuous increase in scores from pre- (2.6) to post-test (3.2) in the treatment group, whereas the means for the control group were similar across measurements. The results of a 2 (group: treatment *vs.* control) × 3 (test occasion; pre, 1 week, 2 week) mixed ANOVA with repeated measures on the later factor, confirmed these impressions. No effect of Group, $F(1, 52)=1.02$, $p=0.32$ was observed. An effect of Measurement occasion, $F(2, 104)=28.03$, $MSE=0.062$, $p<0.001$, $\eta_p^2=0.35$, reflecting lower scores at the follow-up(s). Most important, the Group × Test Occasion-interaction was significant, $F(2, 104)=17.76$, $MSE=0.06$, $p<0.001$, $\eta_p^2=0.26$, in line with the described pattern of selective gains in FFMQ scores following treatment.

Concerning the measures of perceived stress, anxiety, and depression, a similar trend was observed, i.e., a substantial reduction of the mean scores for the treatment group and little evidence of change in the control group. The ANOVA of PSS total score showed an effect of Group, $F(1, 52)=5.30$, $MSE=27.14$, $p<0.05$, $\eta_p^2=0.09$, of Measurement occasion, $F(2, 104)=15.88$, $MSE=27.14$, $p<0.001$, $\eta_p^2=0.23$, and an interaction between the two factors, $F(2, 104)=5.71$, $MSE=27.14$, $p<0.01$, $\eta_p^2=0.10$. The analysis of the PSQ index (with two levels, pre- post), revealed no effect of Group, $F(1, 52)=1.19$, $p=0.28$, but an effect of Test occasion, $F(1, 52)=31.14$, $p<0.001$, $\eta_p^2=0.42$, and a significant interaction between Group and Test occasion, $F(1, 52)=24.09$, $MSE=0.006$, $p<0.001$, $\eta_p^2=0.32$.

Finally, scores on the HADS anxiety and depression subscales showed no effect of Group ($F(1,52)=2.49$, $p=0.12$ for anxiety and $F(1,52)=3.04$, $p=0.09$ for anxiety) but of Test occasion; for anxiety, $F(2, 104)=11.25$, $MSE=4.36$, $p<0.001$, $\eta_p^2=0.18$; for depression, $F(2, 104)=20.54$, $MSE=2.80$, $p<0.001$, $\eta_p^2=0.28$. Finally, for both scales the interaction term was significant; for anxiety, $F(2, 104)=10.73$, $MSE=4.36$, $p<0.001$, $\eta_p^2=0.17$; for depression, $F(2, 104)=10.09$, $MSE=2.80$, $p<0.001$, $\eta_p^2=0.16$.

In sum, the treatment group improved in regard to mindfulness skills as reflected by the FFMQ. There was also a significant interaction between group (treatment *vs.* controls) and test occasion across all of the outcome measures, reflecting decreased score on measures of psychological distress and little change from pretest to follow-up measurements in the control group. These patterns are clearly evident from the effect size estimates that were large (> 0.8 [26] for the treatment

	Treatment group (*n*=20)					Control group (*n*=34)			
Measure	Pre-test	1 week	2 weeks	Cohen's *d*		Pre-test	1 week	2 weeks	Cohen's *d*
FFMQ	2.58 (0.48)	3.05 (0.46)	3.21 (0.61)	1.12		2.79 (0.45)	2.78 (0.48)	2.88 (0.57)	0.18
PSQ-index	0.56 (0.13)	-	0.39 (0.13)	1.32		0.53 (0.16)	-	0.51 (0.19)	0.10
PSS-total	29.85 (4.54)	22.80 (6.49)	21.10 (7.2)	1.42		30.53 (8.65)	29.50 (9.60)	27.91 (10.20)	0.27
HADS-a	10.60 (3.33)	8.2 (2.4)	6.75 (3.27)	1.17		10.12 (4.34)	10.32 (4.44)	10.03 (4.85)	0.02
HADS-d	6.45 (3.07)	3.85 (2.74)	2.95 (2.39)	1.23		6.38 (3.85)	5.83 (3.85)	5.79 (3.98)	0.15

FFMQ=Five Facets of Mindfulness Questionnaire; PSQ=Perceived Stress Questionnaire; PSS=Perceived Stress Scale; HADS-a=Hospital Anxiety and Depression Scale (anxiety scale); HADS-d=Hospital Anxiety and Depression Scale (depression scale)

Table 1: Summary statistics (Means; Standard deviation in parenthesis) for the measures included at pretest, at 1 and 2 week follow-up measurement for the treatment and control group.

group across measures and close to zero (< .30) for the control grpup.

Associations between treatment effects and changes in mindfulness

To test the assumption that the reductions of psychological distress observed at the mean level were attributable to increased mindfulness skills rather than some more general treatment factor, we examined the associations between gain in scores on the mindfulness questionnaire (FFMQ) and reductions in symptom scores at the individual level. For this purpose, we regressed the pretest scores for the measure on the post test scores so as to compute standardized residuals of each measure. Zero-order correlations between treatment-related (residualized) change scores in FFMQ scores and changes perceived stress from pretest to posttest (2 weeks) were significant, (r=-0.46, p<0.05 for PSS and r=-0.62, p<0.01 for PSQ) indicating that (larger) increments in mindfulness were associated with more pronounced reduction of stress. In a similar vein, the gain in FFMQ scores were negatively correlated with the two facets of HADS (r=-0.49, p<0.05 for the anxiety scale and r=-0.63 for the depression scale) suggesting that the foregoing pattern generalized to other symptoms of psychological distress.

Discussion

The objective of the study was to examine the effectiveness of a brief, two-week-, mindfulness program on stress, anxiety, and depression in group of individuals reporting themselves as stressed. Even though this self-report inclusion criterion is vague, mean pretest scores, indicative of severe levels of stress (PSQ>0.45) [21], suggested that the participants were at risk of stress-related health problems.

Overall, the results provides further support that mindfulness training is an effective therapeutic method to reduce perceived stress [6,27,28], anxiety [6,29] evidence pertaining to clinical and non-clinical samples) and depressive symptoms [6]. This conclusion is enforced by the fact that the effects were observed following only two weeks of training. More detailed analyses of data from the 1 week follow-up in fact suggest that substantive effects were obtained already following the first week of training.

The effects of the present program was clearly larger as compared with prior studies involving brief MBIs [13,14], and actually exceed the value reported by Khoury et al. [6] for longer programs (and alternative forms of treatments, such as CBT). The finding that this brief the finding that this brief MBI may be (at least) as effective as the standard (8 week) mindfulness programs and alternative treatments forms, may seem overly positive. The rapid increment of mindfulness skills following training accompanied by a reduction of stress levels seem consistent with other evidence, for example of a reduced cortisol level after only five days of mindfulness training [30], though. Further research should further validate the present findings by comparing the effects of this program with that of a longer program (i.e., involving the same elements, including the web-based format). A comparison with a web-based, but non mindfulness based, control condition (e.g. CBT) might provide further validity evidence.

As noted by, Khoury et al. [6] a majority of MBI studies failed to include an independent measure of mindfulness skills. The present inclusion of the Five Facets of Mindfulness Questionnaire provided important evidence in regard to the internal validity. First, our findings indicated an increase in mindfulness skills that was parallel to the reductions in psychological stress in support of previous observations of quite rapid increments in mindfulness skills following training [10]. Such parallel patterns of changes across measurement appears a prerequisite for arguing that the effects are driven by increased mindfulness skills. Second, more detailed analyses demonstrated a substantial correlations of improvement in mindfulness skills and reductions in stress, anxiety, and depressive symptoms, suggesting that the patterns of co-variation between increased mindfulness skills and treatment-related reductions in symptoms of psychological distress holds at the individual level. Thus, the analyses indicate that mindfulness training per se, rather than non-specific, or global, factors were a basis of the substantial reductions in psychological distress observed in the present study.

Despite major strengths of the research, including a randomized controlled design and repeated measurement of mindfulness skills, a few limitations might be noted. First, despite indications that mindfulness is effective both as compared with wait-list and active control groups [6], inclusion of an active control group, rather than a passive wait-list condition as the present study, is preferable, to rule out placebo effects. Physiological measures of stress (e.g. cortisol levels) should be considered in addition to self-report measures, for the same purpose. Third, the study lacked a long-term follow-up. Even though previous studies suggest that effects of longer web-based programs are quite persistent [11] further research needs to examine the maintenance of effects of the current program. Finally, even though there was no sign that the attrition in the group assigned to mindfulness training was selective, neither in regard to initial stress-levels nor in regard to basic demographic characteristics, the 40%-dropout-rate in this condition may be of concern. On the other hand, an advantage of this home/web-based type of training is that in practice it allows for flexibility in regard to training pace (i.e., a factor that had to be restricted at present for purposes of experimental control). Finally, even though an overweight of females may generally be expected at higher perceived stress levels [21] the fact that the present sample included mainly women (90%) is of potential concern in regard to the external validity of the results.

In conclusion, the results indicated that a two week web-based mindfulness program may be sufficient to obtain large reductions in levels of perceived stress, anxiety and depressive symptoms, with evidence of direct link between increased mindfulness skills and reductions of distress over the study period. The web-based format offers great potential in reaching a large number of individuals at risk of stress-related health problems and may prove to be of particular utility in certain (e.g. patient) groups. A web-based format furthermore eliminates variability in skills of the instructor, which may be a factor in face-to-face setting. Thus, the effectiveness and efficacy of this program deserves to be investigated further in studies including an active control group, a control group receiving an alternative form of web-based treatment, and long-term follow-up measurements to examine the extent to which the treatment effects are maintained.

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