

Mindfulness-based stress reduction and health benefits A meta-analysis

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Abstract

Objective: Mindfulness-based stress reduction (MBSR) is a structured group program that employs mindfulness meditation to alleviate suffering associated with physical, psychosomatic and psychiatric disorders. The program, nonreligious and nonesoteric, is based upon a systematic procedure to develop enhanced awareness of moment-to-moment experience of perceptible mental processes. The approach assumes that greater awareness will provide more veridical perception, reduce negative affect and improve vitality and coping. In the last two decades, a number of research reports appeared that seem to support many of these claims. We performed a comprehensive review and meta-analysis of published and unpublished studies of health-related studies related to MBSR. **Methods:** Sixty-four empirical studies were found, but only 20 reports met criteria of acceptable quality or relevance to be included in the meta-analysis. Reports were excluded due to (1) insufficient information about interventions,

(2) poor quantitative health evaluation, (3) inadequate statistical analysis, (4) mindfulness not being the central component of intervention, or (5) the setting of intervention or sample composition deviating too widely from the health-related MBSR program. Acceptable studies covered a wide spectrum of clinical populations (e.g., pain, cancer, heart disease, depression, and anxiety), as well as stressed nonclinical groups. Both controlled and observational investigations were included. Standardized measures of physical and mental well-being constituted the dependent variables of the analysis. **Results:** Overall, both controlled and uncontrolled studies showed similar effect sizes of approximately 0.5 ($P < .0001$) with homogeneity of distribution. **Conclusion:** Although derived from a relatively small number of studies, these results suggest that MBSR may help a broad range of individuals to cope with their clinical and nonclinical problems.

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Introduction

Coping with the symptoms, disability, and uncertain perspectives of chronic disease is a harrowing challenge for a significant proportion of the population. However, addressing the biopsychosocial adjustment of chronically ill individuals is an area that continues to tax the resources and limits of modern conventional medicine and one for which few professionals have adequate time or training. Programs that do exist to improve the well-being and health status of the chronically ill are often still in their infancy and

typically directed toward a specific illness and limited range of symptoms. A single, relatively brief and cost-effective program that can potentially be applied to a range of chronic illnesses and is able to effect a positive shift in fundamental perspectives toward health and disease should be of great interest.

During the last two decades, a group-intervention program known as mindfulness-based stress reduction (MBSR) has been proposed as just such an approach [1]. This procedure has been employed among patients with a wide variety of chronic clinical ailments, as well among groups of relatively healthy individuals who have hoped to improve their abilities to cope with the normal but often significant stresses of daily life. Preliminary reports have suggested substantial benefits for individuals suffering from chronic pain, fibromyalgia,

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cancer, anxiety disorders, depression and the stresses of contexts as diverse as medical school and prison life (e.g., Refs. [2–4]). However, many of the published studies remain critically unevaluated and may be of questionable scientific rigor or too limited in scope to confirm such claims. A recently published paper provided a valuable critique of mindfulness studies, but without providing a quantitative assessment of existing studies [5].

In this report, we provide a meta-analytic review of all accessible published and unpublished investigations purporting health-related benefits of MBSR. Our aim is to provide an empirical basis for evaluating whether or not evidence exists that MBSR systematically improves health-related dimensions among the chronically ill and others, what and how large the specific benefits may be, and whether more extensive evaluation of MBSR may be warranted.

MBSR is a group program that focuses upon the progressive acquisition of mindful awareness, or mindfulness. The construct of mindful awareness originated in earliest Buddhist documents but is neither religious nor esoteric in nature [6]. Several Buddhist treatises detail an elaborate psychological theory of mind, in which mindfulness consistently plays a central role [7]. Mindfulness is characterized by dispassionate, nonevaluative and sustained moment-to-moment awareness of perceptible mental states and processes. This includes continuous, immediate awareness of physical sensations, perceptions, affective states, thoughts, and imagery. Mindfulness is nondeliberative: It merely implies sustained paying attention to ongoing mental content without thinking about, comparing or in other ways evaluating the ongoing mental phenomena that arise during periods of practice. Thus, mindfulness may be seen as a form of naturalistic observation, or participant-observation, in which the objects of observation are the perceptible mental phenomena that normally arise during waking consciousness. Underlying this concept and approach are the following assumptions: (1) Humans are ordinarily largely unaware of their moment-to-moment experience, often operating in an “automatic pilot” mode; (2) we are capable of developing the ability to sustain attention to mental content; (3) development of this ability is gradual, progressive and requires regular practice; (4) moment-to-moment awareness of experience will provide a richer and more vital sense of life, inasmuch as experience becomes more vivid and active mindful participation replaces unconscious reactivity; (5) such persistent, nonevaluative observation of mental content will gradually give rise to greater veridicality of perceptions; and (6) because more accurate perception of one’s own mental responses to external and internal stimuli is achieved, additional information is gathered that will enhance effective action in the world, and lead to a greater sense of control (e.g., Refs. [1,6,7]).

Health-related benefits derived from such claims should include enhanced emotional processing and coping regarding the effects of chronic illness and stress, improved self-

efficacy and control, and a more differentiated picture of wellness in which stress and ailments play natural roles but still allow enjoyment of life as full and rich (i.e., improved quality of life including general competencies, and affective and social dimensions). Evidence from the following meta-analysis may bear upon confirming or refuting such claims.

MBSR is a structured 8–10 week, group program with groups usually varying between 10 and 40 participants. Groups may be either heterogeneous or homogeneous with respect to disorders or problem areas of participants. Single weekly sessions are typically 2.5 h, and there is an additional single all-day session per course on a weekend day. Each session covers particular exercises and topics that are examined within the context of mindfulness. These include different forms of mindfulness meditation practice, mindful awareness during yoga postures, and mindfulness during stressful situations and social interactions. Because development of mindfulness is predicated upon regular and repeated practice, participants enter upon enrolling into a commitment to carry out daily 45-min homework assignments primarily in the form of meditation practice, mindful yoga and applying mindfulness to situations in everyday life.

For the purpose of the current review, we examined 64 empirical reports that either used the structured MBSR program or applied mindfulness procedures as the central component of a group procedure to improve health-related measures.

Methods

Methods of the analysis and inclusion criteria were specified in advance and documented in a protocol.

Inclusion criteria

Criteria for the inclusion of studies included the following:

1. Studies were published before 12/2002 or, in the case of unpublished material, relevant information obtained before 12/2001.
2. Published, as well as unpublished, investigations were included. A minimum requirement for inclusion was the availability of an abstract in the English language.
3. Programs emphasized a mindfulness-based intervention, with mindfulness operationalized as the following:
 - 3.1. Moment to moment awareness to be cultivated with a nonjudgmental attitude.
 - 3.2. Teaching of formal meditation techniques.
 - 3.3. Stressing the importance of daily and systematic practice.
4. Interventions were group taught, i.e., no individual training.

5. Courses were based on a length of 6–12 weeks with approximately 2.5 h per week; intensive meditation retreats were not included.
6. Quantitative outcome measures were available.
7. Outcome measures could be subsumed under dimensions of physical or mental health.
8. Outcome measures were derived from standardized and validated scales.
9. Available data of each study allowed for the calculation of effect sizes.
10. Controlled studies were required to have a control group procedure that was either inactive (wait-list) or active in the sense that they were oriented to controlling for nonspecific effects of the mindfulness group (e.g., social support, demand characteristics and expectancy effects).
11. Postintervention, and not necessarily follow-up, data were provided and assessed.

Literature research

Several search strategies were applied:

1. An electronic search was conducted in the following databases: *Medline*, *PsychInfo* including *Digital Dissertations*, *Psycdex Plus*, *Web of Science* including *Science Citation Index* and the *Cochrane Library*. Databases were searched for the occurrence of the keywords *mindfulness*, *Vipassana*, *insight meditation*, *stress reduction* and *mind/body* anywhere in the record.
2. We inspected the reference sections of all retrieved studies, as well as in a set of theoretical publications on mindfulness meditation.
3. We contacted the first authors of all identified studies assessing the effect of a mindfulness meditation intervention and asked them for unpublished material, ongoing research and whether they knew of any other researchers having unpublished data or ongoing studies.

Study coding

All studies meeting the above inclusion criteria were coded by the second author (LN). Studies were coded for their *design* (controlled study, observational study, follow-up data), *group allocation* (randomization, quasiexperimental), *type of control* (waiting list, no treatment, treatment as usual, active control), *study population* (patients, nonpatients, students, inmates, etc.), *patients' diagnoses*, and *outcome measures*. All coding was later verified by the first author (PG).

Data selection and extraction

The aim of our meta-analysis was to assess the effect of a mindfulness meditation intervention on health status measures. We considered the concept of health to include both physical and mental health. All outcome measures

were either subsumed under “physical health”, “mental health” or were excluded from the analysis. We only included data from standardized and validated scales with established internal consistency (e.g., the Global Severity Inventory of Symptom Check List—R, Hospital Anxiety and Depression Scale, Beck Depression Inventory, Profile of Mood States, McGill-Melzack Pain-Rating Scale, Short Form 36 Health Survey, and Medical Symptom Checklist; a full list is available upon request). Also a conservative procedure was chosen to exclude relatively ambiguous or unconventional measures, e.g., spiritual experience, empathy, neuropsychological performance, quality of social support, and egocentrism.

“Mental health” constructs comprised scales such as psychological wellbeing and symptomatology, depression, anxiety, sleep, psychological components of quality of life, or affective perception of pain. “Physical health” constructs were medical symptoms, physical pain, physical impairment, and physical component of quality of life questionnaires.

All decisions on the inclusion and allocation of outcome measures were based on consensus discussions among LN, PG and HW (last author). Relevant data for every measure included into the analysis were extracted and entered into an Excel spreadsheet.

We examined immediate, pre to postintervention change to assess effects of mindfulness training—and *not longer term effects*—due to lack of follow-up data in several studies and because follow-up periods varied so greatly in elapsed postintervention duration. Our results, therefore, merely indicate the presence or absence of short-term responses and do not directly address any long-term effects.

Effect size calculation

We calculated Cohen's *d* effect sizes by dividing the mean difference by their pooled standard deviation. Two types of mean differences were employed: (i) treatment-control difference (between-group), and (ii) posttreatment-pretreatment difference (within-group). We included the latter, within-group analyses because there were a relatively small number of controlled studies that met criteria, and several rather carefully conducted uncontrolled observational studies that did adhere to criteria. Additionally, we believed that it might be informative to compare effect sizes between observation studies, and both randomized and quasiexperimental controlled investigation.

In the case of (i), posttreatment values are usually entered into the equation assuming no baseline difference between groups before the intervention. As this assumption could not always be maintained for our data set, we calculated two effect sizes, one based on the pretreatment values (baseline difference) and one on the posttreatment values. The final effect size entering the meta-analysis was obtained by subtracting the baseline difference from the effect size for the postintervention values.

For the calculation of the (ii) pre–post effect sizes, the correlation between pre- and postintervention measures is needed. As this correlation could not be obtained from the study reports, we entered a global estimation of $r=.7$ into the formula [8]. All effect sizes were corrected for small sample bias by a simple formula provided by Hedges [9].

Data aggregation

We first integrated all effect sizes within a single study by the calculation of means into two effect sizes, one for mental and one for physical health. If the sample size varied between scales of one study, we weighted them for N . Effect sizes obtained in this manner were aggregated across studies by the computation of a weighted mean, where the inverse of the estimated standard deviation for each investigation served as a weight [8]. Confidence intervals (CI) were based on the overall mean effect size's standard error calculated by the formula

$$SE_d = \sqrt{\frac{1}{\sum w_i}} \quad (1)$$

with w_i being the single study's weight [8]. Two-tailed P values were calculated by the computation of a z score with $z=d/SE_d$. Homogeneity of treatment effects across studies were tested by computing a formula that provides a Q value, which is χ^2 distributed with $df=k-1$, with k standing for the number of studies entering the test [9].

Overall and sensitivity analyses

We calculated two separate meta-analyses. The first included all controlled studies with the effect size based on the comparison between the experimental and the control groups. The second analysis used data from both controlled studies (employing only results from the mindfulness intervention) and observational studies (i.e., in which no control group existed). Regarding the latter set of analyses, we aggregated all effect sizes based on a pre–post difference for groups undergoing mindfulness training. For both analyses, we calculated separate mean effect sizes for mental and physical health. Sensitivity analyses were calculated for several subgroups by splitting the data set and by calculation of separate analyses for each subgroup.

Results

We retrieved 64 studies but only 20 reports, comprising a total of 1605 subjects, met the inclusion criteria (noted in *References* with an asterisk and in *Further Readings*; note that some studies were presented in more than one publication). A list of all retrieved studies are included in Appendix A. Most of the excluded studies did not operationalize mindfulness training in the specified manner or reported insufficient statistical details for effect size calculation.

Studies investigating mindfulness training among medical patients included the following diagnoses: Fibromyalgia, mixed cancer diagnoses, coronary artery diseases, depression, chronic pain, anxiety, obesity and binge eating disorder.

Table 1
Overview of controlled studies included in the meta-analysis

Study	Year	Pub. status	Sample	Diagnosis	Design	Control group	N	N_t	N_c	MH	PH	d_{MH}	d_{PH}
Bruckstein [21]	1999	d	pat.	Chronic pain	QE	attention placebo	22	15	7	4	2	0.53	0.75
Murphy [25]	1995	d	pris.	–	RCT	Jacobson relaxation	31	15	16	3	–	0.30	–
Perkins [24]	1998	d	pris.	–	RCT	WL	97	49	48	4	–	0.49	–
Rosenzweig et al. [26]	2003	u	stud.	–	QE	seminar	277	125	152	2	–	0.54	–
Sephton et al. [18]	2001	ab	pat.	Fibromyalgia	RCT	WL	55–65	22–27	33–39	4	2	0.67	0.25
Shapiro et al. [4]	1998	p	stud.	–	RCT	WL	73	36	37	4	–	0.62	–
Specia et al. [2]	2000	p	pat.	Cancer	RCT	WL	90	53	37	2	–	0.54	–
Tiefenthaler-Gilmer [23]; and Tiefenthaler and Grossman [22] (1 study)	2002, 2002	u, ab	pat.	Fibromyalgia	QE	social supp., relaxation and exercise group	38	25	13	4	1	0.52	0.30
Williams, Larkin et al. [19]	2001	u	pat.	Coronary artery dis.	RCT	stress management training	21	11	10	8	1	0.46	0.29
Williams, Kolar et al. [20]	2001	p	vol.	–	RCT	educational material given	47–57	28–32	19–26	2	1	0.56	1.01
Overall							771	388	385	37	7		

Pub. status, publication status (d, dissertation; u, unpublished; ab, abstract, p, published), sample (pat., patients; pris., prisoners; stud.; students; vol., volunteers), design (RCT, randomized controlled trial, QE, quasiexperimental design), control group (WL, waiting list control), N , total number of subjects in this study, N_t , number of subjects in the treatment group, N_c , number of subjects in the control group, MH, number of mental health scales employed in the study, PH, number of physical health scales employed, d_{MH} mean effect size for all mental health scales, d_{PH} mean effect size for all physical health scales. All numbers refer only to study completers.

Ranges within N , N_t and N_c refer to different scales.

der, and psychiatric patients. Two reports were based on prison populations, and three included nonclinical samples who sought to improve coping with stress.

Controlled studies

Thirteen of the qualified investigations included control groups. However, we excluded another three studies from the data set for the following reasons. One study compared mindfulness meditation to a well-established psychoeducational program of proven efficacy [10]. This did not fulfill our criteria of an active “control” procedure but represented a comparison study; findings of this study were, however, included in the section below, “Observational Studies”. Two other investigations provided only follow-up data, but did not report posttreatment scores in a proper time-frame for our investigation and were also excluded (Refs. [3,11,12]; the latter two represent different findings from the same study). Of the remaining 10 studies, seven were properly randomized and three had a quasiexperimental design. Five studies had patients as subjects, and a variety of control procedures were applied (see Table 1).

Table 2 provides results (mean effect size, 95%-CI, P value) for the mental health variables of all controlled studies. Data of a total of 771 individuals are shown, with 388 of them receiving a mindfulness training. The table also shows the results for the subsamples obtained by splitting the data set for the factors *subject population* (patients vs. nonpatients) and *group allocation* (randomization vs. quasiexperimental control). Only five of the controlled studies applied physical health variables as outcome measures.

For the *mental health* variables the data set proved to be homogeneous ($\chi^2=0.89$, $df=9$, $P=.999$). It yielded a significant medium strength effect size [13] of $d=0.54$ (95%-CI 0.39–0.68, $P<.0001$, two-tailed). Sensitivity analyses of

Table 2

Mean effect size, d , 95% confidence intervals (CIs) and P values (two-tailed) calculated for the difference between mindfulness meditation and control group on mental health and physical health variables for all controlled studies

	k	N	d	95%-CI	P
<i>Mental health variables</i>					
All studies	10	771	0.54	0.39–0.68	<.0001
Patients	5	236	0.56	0.29–0.83	<.0001
Nonpatients	5	535	0.53	0.36–0.70	<.0001
Randomized	7	434	0.54	0.35–0.74	<.0001
Quasiexperimental	3	337	0.54	0.32–0.76	<.0001
<i>Physical health variables</i>					
All studies (4 patients and 3 randomized)	5	203	0.53	0.23–0.81	<.0004

Subgroups of studies with patients, nonpatients, randomized design and quasi-experimental-design are noted only for mental health measures. The very limited number of studies with physical health variables precluded the usefulness of calculating separate CIs.

Table 3

Effect of mindfulness training based on a pre–post comparison for mental and physical health variables (k , number of studies; N , number of subjects; d , mean effect size; P value, two-tailed)

Variables	k	N	d	95%-CI	P
Mental health	18	894	0.50	0.43–0.56	$P<.0001$
Physical health	9	566	0.42	0.34–0.50	$P<.0001$

the subgroups showed no significant differences for the variables *subject population* or *group allocation*.

Only five of the controlled studies reported data that could be subsumed under *physical health*. Results for 203 individuals are included, 122 of whom received mindfulness instruction. This reduced data set also proved to be homogeneous ($\chi^2=4.97$, $df=4$, $P=.29$). The summary results are also presented in Table 2. The mean effect size of $d=0.53$ (95%-CI 0.23–0.81, $P=.0004$) is similar to that of the mental health variables.

Observational studies

Table 3 shows the results for pre- to postintervention comparisons for both sets of outcome measures (physical and mental health). Overall data from 18 investigations and 894 individuals receiving mindfulness training entered the data set. Only nine studies with 566 individuals assessed variables of physical health. The mean effect sizes, $d=0.50$ (95%-CI 0.43–0.56, $P<.0001$) for mental health, and $d=0.42$ (95%-CI 0.34–0.50, $P<.0001$) for physical health are relatively similar to the results of the controlled studies. Both effect sizes are also significant but only the set with physical health parameters proved to be homogeneous ($\chi^2=11.45$, $df=8$, $P=.18$); the other set did not pass the test of homogeneity (mental health $\chi^2=51.92$, $df=17$, $P<.0001$).

Employing a sensitivity analysis, we, therefore, assessed whether the variable *subject population* moderated the effect. Results indicated that each subgroup (patients and others) showed significant heterogeneity (patients, $\chi^2=33.29$, $df=12$, $P<.001$; nonpatients, $\chi^2=15.84$, $df=4$, $P=.003$). Thus, this mean effect size should be interpreted with caution.

Discussion

Our findings suggest the usefulness of MBSR as an intervention for a broad range of chronic disorders and problems. In fact, the consistent and relatively strong level of effect sizes across very different types of sample indicates that mindfulness training might enhance general features of coping with distress and disability in everyday life, as well as under more extraordinary conditions of serious disorder or stress. Another recently published study employing different inclusion criteria and a somewhat

divergent strategy also provides additional support for the effectiveness of mindfulness interventions [28]. In both investigations, improvements were consistently seen across a spectrum of standardized mental health measures including psychological dimensions of quality of life scales, depression, anxiety, coping style and other affective dimensions of disability. Likewise, similar benefits were also found for health parameters of physical well-being, such as medical symptoms, sensory pain, physical impairment, and functional quality-of-life estimates, although measures of physically oriented measures were less frequently assessed in the studies as a whole.

Results of other carefully performed trials that did not conform to our criteria of timeframe, dependent measures, or control procedures also point to the efficacy of mindfulness training [3,10]. For example, a recent randomized study of depressives in remission found one-year relapse rates of major depressive episodes to be halved when conventional treatment was supplemented by a mindfulness program [3]. Another investigation of mindfulness training among anxiety and mood disorder patients showed pre- to postintervention improvements in mental health outcomes with an effect size of 0.7 [10].

In our meta-analysis, the similarity of effect sizes across types of study (e.g., controlled vs. observational) and within the controlled-study analysis (active control vs. wait list) does provide some support for the specificity of the mindfulness intervention. Particularly relevant here are those six controlled investigations (see Table 1) that employed forms of active control intervention to account for general or nonspecific effects of treatment. These studies show a mean effect size of almost 0.49, not far removed and not significantly different from the mean effect size observed in the four wait-list groups ($d=0.58$) that lacked control of most nonspecific effects of intervention. Nevertheless, such inferences must be weighed very cautiously due to the modest number of total, and particularly of randomized, studies, the diversity of types of sample diagnoses, and the inclusion of unpublished investigations.

Several other caveats must be also addressed regarding these mindfulness studies and our analyses: Due to the limited number of investigations with comparable follow-up data or with follow-up data at all, the meta-analysis was restricted to the more or less immediate effects postintervention. Whereas several investigations do point to long-term benefits of mindfulness training [3,14–17], much additional research is required to confirm such benefits. Secondly, most studies reviewed suffered from methodological deficiencies beyond merely the type of design as randomized, quasiexperimental or observational. Insufficient consideration or information was typically given about participant dropout rate, other concurrent interventions during the mindfulness training period, therapist adherence to intervention program, evaluation of therapist training and competence, description of interventions, adequate statistical power to calculate intervention effects,

or the clinical relevance of results. Additionally, the construct of mindfulness itself, although central to all interventions, was neither operationalized nor evaluated for change in any study. Inasmuch as it is assumed that the primary effects are achieved by acquisition of mindful awareness, characterization of alterations in mindfulness would seem to be essential, and there have been recent attempts to operationalize the concept of mindfulness [6,27].

Only large-scale and sound research in the future will be able to bridge this schism between methodological deficiencies, on the one hand, and the potential promises of mindfulness training, on the other, as consistently revealed by a number of positive studies (varying widely in scientific rigor). Thus far, the literature seems to clearly slant toward support for basic hypotheses concerning the effects of mindfulness on mental and physical well-being. Mindfulness training may be an intervention with potential for helping many to learn to deal with chronic disease and stress. Nevertheless, we now need to test these claims more thoroughly by using well-defined patient populations, applying more stringent methodological procedures, and assessing objective disease markers in addition to self-reported psychosocial and functional indicators of distress.

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Appendix A. All retrieved studies related to mindfulness

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