Title. Mindfulness-Based Stress Reduction and Mindfulness-Based Cognitive Therapy for psychological health and wellbeing in non-clinical samples: A systematic review and meta-analysis.

Author details

Dawn Querstret[1 4]; Linda Morison[2]; Sophie Dickinson[2]; Mark Cropley[2]; Mary John[2 3]

[1]Faculty of Sport, Health and Applied Science, St Mary's University, London, TW1 4SX, UK. Email: dawn.querstret@stmarys.ac.uk, Phone: +44 (0)20 8240 4161.

[2]School of Psychology, University of Surrey, GU2 7XH, UK.

[3]Sussex Partnership NHS Foundation Trust, Aldrington House, 35 New Church Road, Hove, BN3 4AG, UK.

[4] School of Health Sciences, University of Surrey, Guildford, GU2 7YH, UK.

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Abstract

Much of the burden associated with poor mental health is associated with symptom experience in the general population. We conducted a systematic review and meta-analysis of studies conducted in non-clinical samples, evaluating Mindfulness-Based Programs (MBPs) for outcomes related to psychological health and well-being. We focussed on Mindfulness-Based Stress Reduction (MBSR) and Mindfulness-Based Cognitive Therapy (MBCT) because they have the strongest evidence base. We searched MEDLINE, PsycINFO, EMBASE and CINAHL (2006 – February, 2019) for published peer-reviewed journals articles of intervention studies evaluating MBCT or MBSR for psychological health and well-being in non-clinical samples. Data were pooled using a random-effects model and effect estimates were reported as Hedges' g. We included 49 studies conducted in non-clinical samples (n=4733). When compared to a passive control, MBPs significantly reduced symptoms of *rumination/worry* (*g*=-1.13, [-2.17, -0.08]), *stress/psychological distress* (g=-0.52 [-0.68, -0.36]), *depression* [g=-0.45 [-0.64, -0.26]), and *anxiety* (g=-0.44 [-0.65, -0.23]); and significantly improved *quality of life/well-being* (g=0.32 [0.10, 0.54]). In general, MBCT generated larger effect sizes than MBSR for all outcomes. This study provides evidence that in non-clinical samples, MBPs are associated with benefits to health and well-being. These findings add to the growing evidence-base suggesting that MBSR and MBCT may be effective approaches for sub-clinical levels of mental ill-health and could form part of the public mental health agenda.

Keywords

Mindfulness-based Interventions; MBIs; MBCT; non-clinical samples; psychological health

What defines good/optimal psychological health and well-being? Is it when people report no symptoms or symptoms that are below the threshold to meet diagnostic criteria for mental health disorders (e.g., of depression or anxiety); or is it when people are flourishing (enjoying a positive state of mental health and well-being)? We argue that it is all of these. The question is, how do you enhance psychological health and reduce disorder at the same time? First posited by Rose (1992), the population approach to health recognises that people with the most severe symptoms occupy the smallest tails in the population distribution, and that there is an 'inextricable link' between people most severely afflicted and people who are in the middle of the distribution – who are considered 'normal'. Rose (1992, 2008) and others (e.g., Huppert, 2009; Razak, Davey Smith, & Subramanian, 2016) have argued that in order to reduce the burden associated with disorder, it is advisable to shift the mean of the population, since the future 'severe' cases will typically come from this 'normal' population. In the context of improving the mental health of the general population, this would suggest that exposing people from the middle of the distribution to interventions to reduce psychological ill-health and improve well-being would be advantageous.

The distinction between 'clinical' and 'non-clinical' in reality simply denotes a distinction between individuals that have sought diagnosis and treatment from individuals who have not; or individuals whose symptoms have reached a (socially determined) threshold on mental health measures classifying them either as 'disordered enough to meet the criteria for treatment' or as 'normal' (Huppert, 2009; Rose, 1993). In reality though, no such separation exists (Rose, 1993). Published reports which do present complete distributions of scores for measures of psychological distress, depression or dementia have demonstrated that – just as with IQ scores – scores from these measures form a continuum of symptom experience (e.g., Gurland et al., 1983; Brenner, 1985; Brayne & Calloway, 1988; Anderson, Huppert, & Rose, 1993). Definitions of 'caseness' are necessary wherever decisions regarding treatment are required which leads to a dichotomy ('treat' or 'not treat'). In the context of mental health services with limited resources the need to establish criteria whereby people qualify for treatment is understandable; however, these criteria should be recognised for what they are which is an "operational convenience" (Rose, 1993, p.553).

There is a large (and growing) number of people in the community experiencing symptoms of mental ill-health and well-being that do not meet full diagnostic criteria for clinical mental health conditions (Rodriguez, Nuevo, Chatterji, & Ayuso-Mateos., 2012), and there are also people with symptoms who do not seek or cannot access formal help. Furthermore, there are many symptoms which do not feature in diagnostic criteria for mental health disorders but that still interfere with everyday functioning and enjoyment of life (Rodriguez et al., 2012). Furthermore, relatively few people are in a stage of positive mental health (i.e., flourishing) which suggests there is scope to enhance their well-being (Huppert, 2009). Much of the burden of disability in the population is attributable to symptom experience rather than to diagnosed mental health disorders (Judd, Schettler, & Akiskal, 2002; Rose, 1993); and many individuals who do not meet diagnostic criteria may still be suffering in their daily lives (Keyes, 2002). Therefore, to be effective, prevention should address the whole range of the problem. In the context of mental health disorder, "the visible part of the iceberg (prevalence) is a function of its total mass (the population average), and the one cannot be reduced without the other" (Rose, 1993, p.554).

Anderson et al. (1993) provided evidence that a small shift in the population mean could be associated with a substantial reduction in the prevalence of common mental disorders. The authors used data from the British Health and Lifestyle Survey (N > 6000) and divided the sample into different population groups defined by their sociodemographic characteristics (e.g., age, gender, geographical region). There was a direct association between people with clinically significant disorder and the mean score on the General Health Questionnaire (GHQ; the scale included in the survey that that measured the symptoms of psychological distress). Using linear regression, Anderson et al. predicted that for every one-point drop in the population mean symptom score, there would be a corresponding 7% drop in prevalence of disorder; a prediction which was substantively supported in a 7-year follow-up study by Whittington and Huppert (1996). Whittington and Huppert found that for every one-point decrease on the GHQ, there was a corresponding reduction in prevalence of 6%; and that as the mean decreased, more people from the sample moved into a 'no symptoms' category. Therefore, shifting the mean of the population down by reducing symptoms associated with poor

mental health may reduce the prevalence of mental health disorder in the future, thereby reducing service need. As such, providing access to mental health interventions to people not meeting the diagnostic criteria but who are also not 'flourishing' is advisable. In order to do that, it is firstly necessary to understand the types of interventions which may be effective in 'non-clinical' samples for improving mental health and well-being.

We chose to focus our meta-analysis on the effectiveness of Mindfulness-Based Stress Reduction (MBSR; Kabat-Zinn, 1982) and Mindfulness-Based Cognitive Therapy (MBCT; Segal, Williams, & Teasdale, 2002) programs for psychological health and well-being in studies conducted in non-clinical samples. We focused on MBSR and MBCT programs — so-called 'first-generation' Mindfulness-Based Programs (MBPs) — because they have the strongest evidence-base. While aspects of MBSR and MBCT are drawn from Buddhism, these programs have been developed in such a way that wide-spread community adoption could be possible (Crane et al., 2017). They are "based in science and contemporary approaches to managing mental and physical health and supporting well-being; they are suitable for delivery in mainstream public institutions across a range of settings and cultures; and they are maximally accessible to people with diverse values and religious affiliations" (Crane et al., 2017, p.991). As such, while they were originally developed for reducing the prevalence of mental health disorder, they are also well-suited for populations evidencing sub-clinical levels of psychological ill-health, and to encourage the development of positive mental health and well-being.

MBSR was developed as an adjunct treatment for patients with chronic pain (Kabat-Zinn, 1982, 1990) whereas MBCT, adapted from the MBSR model, was developed to treat recurrent and treatment-resistant depression (Segal et al., 2002). The original protocols for both programmes mandate delivery over 8-weeks (one 2.5-hour session/week for MBSR; one 2-hour session/week for MBCT), by a qualified mindfulness trainer face-to-face to groups of participants. Mindfulness practices (formal and informal) make up a significant proportion of both the MBSR and MBCT curriculums. Formal practice occurs through taught meditative techniques (e.g., body scan, mindful movement, mindful yoga) both in session and daily (as homework); whereas informal practice — which involves developing awareness of body sensations, thoughts, emotions and sensory input

(sights, scents, sounds) — is practiced via day-today activities like eating a meal, brushing teeth and walking (Kabat-Zinn, 2003). Mindfulness practice cultivates awareness of cognitive, emotional and physical processes ('present-moment awareness'). This enables people to experience these processes with a non-judgemental and non-reactive attitude ('non-judgemental acceptance') which in turn helps increase psychological flexibility; thereby reducing engagement in maladaptive habits and reactions (Young et al., 2018; Kabat-Zinn, 1990; Segal et al., 2002).

There is growing evidence from systematic reviews and meta-analyses for the effectiveness of MBPs. Meta-analyses conducted in clinical samples have shown that MBCT is effective for preventing relapse in Major Depressive Disorder with risk ratios ranging from 0.66 (Piet & Hougaard, 2011) to 0.69 (Kuyken et al., 2016). Mindfulness interventions (MBSR and MBCT predominantly) have also been shown to be effective for the reduction of symptoms associated with common psychiatric disorders reporting moderate effects on depression, ranging from g=.040 to g=0.59 (Hedman-Lagerlof, Hedman-Lagerlof, & Ost, 2018; Goldberg et al., 2018) and a large effect on anxiety, g=0.89 (Goldberg et al., 2018). Khoury et al. (2013) conducted a meta-analysis on studies (N=209) assessing mindfulness interventions (mostly MBSR and MBCT) across both clinical and non-clinical samples (n=12,145), and found that they were more effective than other treatments for depression (g=.69) and anxiety (g=.89). In Carmody and Baer's (2009) meta-analysis, MBSR interventions in clinical and non-clinical samples (n=1393), produced a moderate effect size for reducing psychological distress in both clinical (mean d=0.65) and non-clinical (mean d=0.66) samples.

Systematic reviews and meta-analyses have also synthesised and evaluated results of studies conducted in non-clinical samples (general population, working adults, students). For example, Chiesa and Serretti (2009) conducted a meta-analysis of the effectiveness of MBSR in studies (N=10) carried out in 'healthy people' and reported a significant reduction in stress (t=21.01, p<.0001) when comparing MBSR (d=0.74) to control (d=-0.21) groups. Eberth and Sedlemeier (2012) conducted a meta-analysis of studies (N=39) within non-clinical samples and reported that MBSR was moderately effective for the reduction of anxiety (mean weighted effect, r=0.30) and stress (mean weighted effect, r=0.37) and that it increased well-being (mean weighted effect, r=0.37). Khoury et al. (2015) carried

out a meta-analysis of studies (N=29) evaluating the effectiveness of MBSR interventions in non-clinical samples (n=2668), and found that MBSR was effective in reducing symptoms of stress (*g*=.74), anxiety (*g*=.64), burnout (*g*=.26) and depression (*g*=.80) and for increasing quality of life (*g*=.53). Virgili (2015) conducted a meta-analysis of studies (N=19) conducted in working adults (n=1139) evaluating the effectiveness of mindfulness-based interventions (including MBSR, variants of MBSR, and workplace interventions which included elements of mindfulness) for psychological distress and reported moderate within-group (*g*=0.68) and between-group (*g*=0.68) effect sizes.

More recently, Jayawardene, Lohrmann, Erbe, & Torabi (2017) conducted a meta-analysis evaluating the effectiveness of MBPs (predominantly MBSR) operationalised online (Internet-based) for stress and mindfulness in studies (N=8) conducted in non-clinical samples (n=1316); and reported a medium effect size for stress (g=0.43) and small effect size for mindfulness (*g*=0.27). Lomas, Medina, Ivtzan, Rupprecht, & Eiroa-Orosa (2018) conducted a systematic review and meta-analysis of studies (N=41) evaluating mindfulness interventions (including MBSR, MBCT, MBSR variants, mindful meditation, resilience training, stress management training, and acceptance training) in healthcare professionals (n=2101). The authors reported significant small to moderate effects of mindfulness interventions for the reduction of anxiety (SMD=-0.49), burnout (SMD=-0.31), depression (SMD=-0.55), stress (SMD=-0.42), and distress (SMD=-0.61); and significant increases in positive well-being (life satisfaction, quality of life, subjective well-being) (SMD=0.27) and mindfulness (SMD=0.34). Finally, a recent meta-analysis evaluated the effectiveness of mindfulness interventions (including MBSR, MBCT, mindful meditation, body scan, hatha yoga, mindfulness for academic success, meditation-based stress management) in studies (N=41) conducted in post-secondary school student samples (n=4211), and reported significant moderate reductions in depression (SMD=-0.49), anxiety (SMD=-0.53), and perceived stress (SMD=-0.39) (Halladay et al., 2019).

While these existing systematic reviews and meta-analyses demonstrate the effectiveness of a variety of mindfulness-based and mindfulness-informed interventions for a multitude of mental health and well-being outcomes, none of them focusses exclusively on MBSR and MBCT in non-clinical samples. Furthermore, many of these reviews and meta-analyses included studies drawn from sub-sets

of the general population, for example specific occupational groups (e.g., Lomas et al., 2018; Virgili, 2015) or university students (e.g., Hallady et al., 2019); or focus only on one specific MBP, for example MBSR (Jayawardene et al., 2017; Khoury et al., 2015; Ebert & Sedlemeier, 2012; Chiesa & Serritti, 2009). Therefore, we sought to build on this growing evidence-base by carrying out a meta-analysis of studies conducted in non-clinical samples, evaluating MBSR and MBCT for psychological health and well-being. We were interested not only in outcomes measuring symptoms related to mental health disorder (e.g., depression, anxiety) but also on outcomes related to flourishing in terms of optimal psychological health (e.g., quality of life/well-being, satisfaction with life).

Review questions

Primary. Are MBSR and MBCT programs effective for improving psychological health and well-being in the general population?

Secondary. Do MBSR and MBCT interventions significantly increase self-reported mindfulness?

Methods

Protocol and registration

The protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO; registration number: CRD42016027639). We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standards (Moher, Liberati, Tetzlaff, Altman, & The PRISMA Group, 2009).

Criteria for inclusion/exclusion

Population. We included studies conducted in adult (18+ years) non-clinical samples which assessed psychological health and/or well-being. We excluded studies that had been carried out in samples of children (<18yrs of age) because our area of interest was in understanding which interventions might be effective in reducing symptoms in non-clinical adult samples, such that these adults do not then go on to develop clinically diagnosable mental health disorder. Furthermore, we believe there are developmental differences between children and adults meaning the results from these different developmental groups are not validly analysed together. We also excluded participants

with specific diagnosed health conditions: for example, cancer; severe and enduring mental health conditions (e.g., major recurrent depressive disorder [MDD], social anxiety disorder [SAD], generalised anxiety disorder [GAD], psychosis, bipolar disorder, schizophrenia, panic disorder [PD], phobias, suicidal ideation, learning disabilities); neurological conditions (e.g., stroke, Transient Ischaemic Attach [TIA], dementia; headache/migraine); degenerative conditions (e.g., multiple sclerosis [MS]); chronic fatigue syndrome (CFS); fibromyalgia; HIV/AIDS; pregnancy; vascular diseases; heart conditions; pain; respiratory conditions (e.g., Chronic Obstructive Pulmonary Disorder [COPD]); smoking, substance abuse, tinnitus, domestic abuse, insomnia, epilepsy, and menopause. We also excluded studies that have been conducted within correctional services due to the high comorbidity with substance abuse; and studies conducted with military veterans.

Type of Intervention. We included: 1) studies assessing MBSR or MBCT; and 2) all formats of delivery (group-based, individual, face-to-face, online (web-based), Skype-based, telephone-based, self-help books, audio and CDs, mindfulness apps, etcetera). We excluded: 1) protocols using other forms of meditation, for example guided or concentration, or a combination of many meditation styles (excluding as a result Loving-Kindness Meditation [LKM]); 3) studies based on meditation instruction, induction, or retreats; and 4) studies that characterised their interventions as MBCT or MBSR but where it was clear that substantial (unrelated) content had also been added because it would not be possible to determine whether it was the mindfulness elements that were the mechanisms of change or the additional unrelated content elements. Where it was not possible to determine whether an intervention was MBCT or MBSR, we excluded the study.

Comparator(s)/control. We included studies which had assessed MBSR/MBCT against a waitlist control, active control, or other intervention(s), and also studies with no control condition.

Outcomes: primary. We included studies if they reported effects on outcomes of psychological health and/or well-being (e.g., depression, anxiety, rumination, worry, stress, burnout/fatigue, emotional exhaustion, quality of life). We finalised the included conceptual variables once the literature search had been completed.

Outcomes: secondary. All of our included studies evaluated mindfulness-based interventions which purport to exert their influence by changing an individual's level of mindfulness; therefore, we also included measures of mindfulness as long as there were also measures of psychological health and/or well-being within the same study (as these were our primary interest).

Study design(s). We included studies with the following designs: Randomised Control Trial (RCT), control trial, quasi-experimental, pre-post, and pilot studies.

Language. Only studies written in English language were eligible for inclusion.

Information sources

Search strategy. Studies were identified by searching the following databases: MEDLINE, PsycINFO, EMBASE and CINAHL from 2006 to February, 2019 (because we were interested in understanding the current landscape with regards to MBP effectiveness). The following search terms were used: 1) Meditation OR Mindfulness OR MBSR OR mindfulness-based stress reduction OR MBCT OR mindfulness-based cognitive therapy; AND 2) Self-help OR app OR book OR web OR online OR Internet OR face-to face OR F2F OR Group* OR individual OR Skype OR audio OR retreat OR course OR Intervention; AND 3) NOT cancer NOT psychosis NOT bipolar disorder NOT personality disorder NOT "posttraumatic stress disorder" NOT PTSD NOT schizophrenia NOT "panic disorder" NOT phobia NOT "learning disab*" NOT stroke NOT TIA NOT dementia NOT headache NOT migraine NOT "multiple sclerosis" NOT MS NOT "chronic fatigue syndrome" NOT CFS NOT fibromyalgia NOT HIV NOT AIDS NOT pregnanc* NOT pain NOT coronary NOT COPD NOT smok* NOT "substance abuse" NOT tinnitus NOT "domestic abuse" NOT insomnia NOT epilepsy NOT menopause NOT "correctional services" NOT prison NOT military. In addition, reference lists of included studies and of other relevant reviews were hand-searched to identify potentially eligible studies.

Study Selection. The third author developed the search strategies for each of the databases and conducted the searches. Titles and abstracts were downloaded into a reference management database (www.refworks.com) where duplicates were removed. Abstracts of articles remaining after initial title review were assessed by the third author and they were scored as: (1) 'positive' (if inclusion criteria

were met), (2) negative (if inclusion criteria not met), or (3) as 'unclear' (if not enough detail was provided in the abstract to make a decision). Articles scored as 'positive' or 'unclear' were retrieved for full text review. Articles retrieved for full text review were reviewed independently by the first and third authors who identified studies which clearly did not meet the inclusion criteria and agreed studies that were to be included. Where there was debate as to whether or not a study met the inclusion criteria, the studies were discussed with the fourth and fifth authors to reach agreement.

Data extraction (selection and coding). Standardised data extraction tables were developed and the first and third authors extracted data from the first five studies in order to agree format and test all fields were completed. Data from all remaining studies were then extracted into the data extraction tables by the third author; and the first author extracted data from a randomly selected sub-sample (10) of the remaining articles to ensure consistency.

Data items. We extracted the following data from our included papers: 1) Demographics of study (authors, year of publication, location, study design, participant details, study aims, hypotheses); 2) Intervention characteristics (type of intervention [MBCT, MBSR]), format of delivery (e.g., Face-to-face group-based, Self-help, online), length of intervention (weeks), amount of 'at home' practice, intensity of training (duration and number of session per week), therapist qualifications, formal mindfulness practices, informal mindfulness practices); and 3) Study characteristics (including control / other treatment condition/s [if applicable], measurement time points, attrition rate, self-report psychological measures, means and standard deviations, effect sizes of within- and between-group analysis, mechanisms of change [if reported], main findings and authors conclusions). We included multiple outcomes from studies provided they met our inclusion criteria.

Risk of bias (quality) assessment: within studies

The methodological quality of each study was assessed using the Quality Assessment Tool for Quantitative Studies (Thomas, Ciliska, Dobbins, & Micucci, 2004), which is comprised of eight components: 1) Selection bias, 2) Study design, 3) Confounders, 4) Blinding, 5) Data collection methods, 6) Withdrawals and drop outs, 7) Intervention integrity, and 8) Analyses. Components 1-6 (inclusive) contribute to the global rating for methodological quality for each study of either 'Strong'

(no 'Poor' ratings), 'Moderate' (one 'Poor' rating) or 'Weak' (two or more 'Poor' ratings). As the remaining two components (Intervention Integrity, Analyses) do not contribute to the Global rating we have not included this data. The 'Selection bias' component of the tool was not suitable for the studies included in our review because most samples were convenience samples drawn from the general population; therefore, the Global rating for each included study considers only the ratings from the other five components. Methodological quality assessment was primarily carried out by the third author, with 50 percent of the studies (N=25) also rated independently by the fifth author. Comparing the two ratings showed that the two raters agreed exactly on the global rating (weak, moderate or strong) for each study (100% agreement, kappa=1).

Calculation of effect sizes

For each outcome a summary effect size (Hedges' g) was calculated using a random effects model to take into account any heterogeneity of treatment effects across studies (Riley, Higgins & Deeks, 2011); and we have interpreted the magnitude of effect size as follows: $g \geq 0.2$ (small), $g \geq 0.5$ (medium), and $g \geq 0.8$ (large; Cohen, 1977). For comparison of MBSR/MBCT groups with controls (between-group analysis) the means and standard deviations post-intervention or other statistics allowing calculation of the effect size were used. If there was more than one MBP in a study, standardised mean differences were calculated comparing each MBSR/MBCT group with the control group separately. There were few active control groups amongst the studies and these varied greatly in type (see Table 1); therefore, the analysis was restricted to comparisons against non-active controls. We felt this approach would provide a more consistent and clearer picture. For within-group change scores, pre- and post-intervention means and standard deviations were used for the calculations as recommended by Lipsey and Wilson (2001). No studies required estimation of the within groups standard deviation from the standard deviation of the differences. For both the between- and within-group analysis relatively few studies included follow-up data and if they did there was a wide range of follow-up durations (see Table 1). As such, in order to get a clearer picture, the analysis was restricted to immediate post-intervention data. Where studies did not report means and standard deviations, we

contacted the authors to request the data and excluded studies if authors did not send us the requested data.

Meta-analytic strategy

Stata version 14 (StataCorp, 2015) was used to conduct meta-analysis (metan command) and meta-regression (metareg command) using the macros described in Palmer and Sterne (2016).

Firstly, the effectiveness of MBPs was assessed for each outcome in two ways: 1) a between-group analysis aggregating data for MBPs compared with non-active controls; and 2) a within-group analysis aggregating data for pre-intervention versus post-intervention comparisons. Secondly, in order to examine whether MBP approach or aspects of intervention implementation explained any of the heterogeneity in outcomes between studies (i.e., whether they moderated the overall effect), meta regression was conducted using command metareg for continuous variables or command xi:metareg for categorical variables. We considered MBP approach (MBSR vs. MBCT) and the following aspects of implementation as moderators: duration of MBP [weeks], minutes per week training, total hours training [weeks x hours], 'standard' relative to 'non-standard' protocol, 'face-to-face group-based' relative to 'self-help delivery', and 'qualified' relative to 'unclear' mindfulness trainer. Each potential moderator was examined individually as the number of studies was not large enough to examine the joint effect of potential moderators together.

For all analyses, heterogeneity of effect sizes was estimated using the Q-statistic and I^2 values. The Q-statistic tests the hypothesis that variance of the effect sizes is no different than would be expected as a result of sampling error alone. I^2 was calculated as an indicator of the proportion of heterogeneity among the studies that is beyond that which may be expected by chance; with values of 25, 50, and 75 considered low, moderate and high respectively (Higgins & Thompson, 2004).

Risk of bias across studies

Publication bias was assessed visually using funnel plots and Egger's test for small sample effects (Egger, Smith, Schneider, & Minder, 1997). In addition, sensitivity analysis was performed whereby each study was omitted in turn and the impact on the individual outcomes inspected (Stata command metaninf). Studies were categorised as having excessive influence if their omission changed

the p-value for the overall effect from significant (<.05) to non-significant (≥.05) or if the point estimate for the overall effect omitting that study fell out of the 95% confidence interval for the original overall effect. Finally, meta regression was used to examine whether outcomes differed between levels of global study quality.

Results

Study selection

The search identified 6800 potentially relevant journal articles. After removal of duplicates, 5805 articles remained. After title and abstract review, 295 articles were retrieved for full text assessment. Overall, 49 studies (represented in 50 journal articles) met the inclusion criteria (see Figure 1). The references list for the included studies can be viewed in the online supplementary materials.

[Insert Figure 1 about here]

Study characteristics

Study design and comparators. Twenty-five of the studies employed a randomised controlled trial (RCT) design, with 19 pre-post, and five quasi-experimental[5 7 37 41 42] (i.e., non-randomised designs). The 25 RCTs evaluated a MBP against: waitlist control (WLC) condition only (N=9), control (CTL) condition only (N=12), other intervention only (N=1; Community Caregiver Education and Support [CCES][44]); or other intervention/s (Physical Activity[14], Relaxation[20 21]; Health Action Process Approach [HAPA][30]; Discussion group[49]) and either WLC[21 30] or CTL[14 20 49] conditions (N=5). The three quasi-experimental studies evaluated a MBP against: CTL condition (N=2)[5 7]; or other intervention (Imagery and Progressive Muscle Relaxation; IMPR) against a CTL condition[37]. See Table 1 for details.

Sample characteristics. There were 4733 participants across the 49 studies, with sample sizes ranging from 9 – 322. Forty out of the 49 studies reported the mean age of their participants (overall mean = 37.62; range 18.73 – 57.6) and 43 studies reported the percentage of female participants (overall percentage = 79.01%; range 44.5% – 100%). While participants for all studies were drawn from the general population, there was a high number of studies explicitly addressing the needs of

university students (N=15) and working adults (N=21), with the remaining studies conducted in convenience community samples (N=13). Twenty-one of the included studies were carried out in the USA, with the remaining studies conducted in the UK[8 24 25 38 42], Canada[6 28 32 37], Netherlands[34 36 37], Hong Kong[19 26 30], Spain[14 31 33], Australia[3 10], Norway[9], France[17], Sweden[21], Malaysia[35], Belgium[39], Ireland[29], and South Korea[44]. See Table 1 for details.

Study outcomes. The majority of studies (N=43) included multiple outcomes meeting our inclusion criteria, with six studies[12 17 18 24 26 29] including only one outcome that met our inclusion criteria. We combined conceptually similar outcomes where appropriate. The constructs measured included: stress/psychological distress (N=33), depression (N=20), anxiety (N=16), burnout/fatigue (N=16), quality of life/well-being (N=13), rumination/worry (N=8), and mindfulness (N=22). Some studies operationalised mindfulness as a unidimensional construct, analysing only a total score (N=13); whereas other studies considered it as a multi-faceted construct, analysing total and/or sub-scales (for the mindfulness facets of acting with awareness, describing, observing, non-judging, and non-reacting) scores (N=12). In almost all studies, conceptual variables were measured using well-validated and reliable self-report questionnaires; however, one study used a single item to measure Burnout[27].

[Insert Table 1 about here]

Mindfulness-Based Program (MBP) characteristics

MBP approach. Out of the 49 studies, 38 included MBSR interventions, and 11 included MBCT interventions. While all studies stipulated they had largely followed the MBSR/MBCT protocols, 32 of the MBPs deviated from the standard protocol in some way (see details below).

Implementation characteristics. Forty-four of the 49 studies included MBP interventions which were delivered face-to-face in groups, with one study delivering their MBSR intervention in a group-based format over teleconference[4]. Three studies included MBSR studies delivered on the Internet (online)[30 33 45], and four studies included MBCT interventions delivered either online[24 38] or via a self-help book[25 49]. One study evaluated MBCT delivered via face-to-face group and also as a self-help intervention[49]. Eleven of the MBSR interventions were delivered in adherence to the standard 8-week protocol, with the remaining studies either shortening or lengthening the duration of their

interventions (range 4-10 weeks). For the MBCT interventions, seven were delivered over 8-weeks[8 13 14 25 38 39 49] with the remaining interventions delivered over 4-weeks[24 27 35] and 11-weeks[36]. The intensity of training (measured as minutes per week excluding home practice time) ranged from 30 minutes to 210 minutes per week. Twenty-four out of the 49 studies provided details suggesting that the mindfulness trainers were formally qualified. The remaining 25 studies either did not specify whether or not the trainers were qualified (N=23) or provided information suggesting that the trainers were not formally qualified (N=2). While the majority of studies suggested that 'at home' practice was part of their protocol, very few actually reported whether participants completed their 'at home' practice. See Table S1 (online supplementary material) for detailed implementation characteristics for each study.

Risk of bias within studies

When assessing the included studies against the criteria in the Quality Assessment Tool for Quantitative Studies (Thomas et al., 2004), 40 out of the 49 studies achieved a global rating of either 'Strong' (N=24) or 'Moderate' (N=16), and the remaining nine studies[7 15 22 24 27 30 33 37 41] were awarded a global rating of 'Weak'. The 'Weak' ratings were awarded to studies predominantly due to study design and poor control of possible confounders (i.e., non-randomised or cohort designs; N=6)[7 15 22 24 27 33 37 41], and lack of reporting with regard to withdrawals and drop outs (N=4)[24 27 33 37 41]. The studies that were awarded 'Weak' ratings mostly delivered MBSR interventions (N=7)[7 15 22 30 33 37 41]. Detailed ratings for each study can be viewed in Table S2 (online supplementary material).

Impact of MBPs

Between-group effects. Tables 2 and 3 show that the aggregated effect of MBPs (overall) were all in a direction indicating a beneficial effect (i.e. reductions in symptoms and increases in well-being measures and mindfulness) and were significantly different from zero apart from burnout/fatigue (g=-.20; p=.091). Effect size was large for rumination/worry (*g*=-1.13); moderate for stress/psychological distress (*g*=-0.52), depression (*g*=-0.45), anxiety (*g*=-0.44), quality of life/well-being (*g*=0.32), mindfulness (total; *g*=0.53), non-reacting (*g*=0.53), and observing (*g*=0.46); and small for describing (*g*=0.20), non-judging (*g*=0.25), and acting with awareness (*g*=0.31).

Within-group effects. Tables 2 and 3 show that effects for MBPs overall were significantly different from zero for all outcomes and were in a beneficial direction. Effect sizes were large for stress/psychological distress (*g*=-0.99); moderate for rumination/worry (*g*=-0.56), depression (*g*=-0.55), anxiety (*g*=-0.47), burnout/fatigue (*g*=-0.49), quality of life/well-being (*g*=0.56), mindfulness (total; *g*=0.50), acting with awareness (*g*=0.60), non-reacting (*g*=0.72), observing (*g*=0.45) and non-judging (*g*=0.45); and small for describing (*g*=0.24).

[Insert Table 2 about here]

[Insert Table 3 about here]

The I^2 percentage and the p-values from the Q statistic showed significant heterogeneity in effect sizes across studies for all outcomes apart from the 'describing' facet of mindfulness and the within-group analysis for 'rumination/worry'. For Forest plots for all between- and within-group analysis for each outcome, see supplementary material (online).

Moderator analysis

With regards to MBP approach, in general MBCT generated larger effect sizes than MBSR. In the *between-groups analysis* the effect sizes for MBCT were significantly larger than those associated with MBSR for depression (p=.013) and anxiety (p=.005); and, although the differences did not reach statistical significance, this trend continued for stress/psychological distress, burnout/fatigue, acting with awareness, non-judging, observing, and non-reacting. With respect to rumination/worry, MBSR (*g*=-2.48) generated a larger effect than MBCT (*g*=-0.37); however, for this outcome the number of studies was low (N=5) and the 95% confidence interval for MBSR was wide and included zero (-5.97, 0.97) suggesting imprecision in the estimate. There was very little difference between MBCT and MBSR for describing. In the *within-groups analysis* the effect sizes for MBCT were significantly larger than those associated with MBSR for mindfulness (total) (p=.003) and describing (p=.045); and, although non-significant, this trend continued for anxiety, depression, burnout/fatigue, rumination/worry, acting with awareness, non-judging, non-reacting, describing and observing. However, there was no difference between MBSR and MBCT for stress/psychological distress. All of the studies assessing quality of life/well-being as an outcome evaluated a MBSR intervention.

The pattern for the other potential moderators was less consistent but aspects of implementation relating to 'duration of the intervention (weeks)', 'intensity of training (minutes per week)' or 'total training (weeks x hours)' showed some associations. Generally, longer interventions with more training time were associated with increased 'quality of life/well-being', 'non-judging' and 'non-reacting'. There was also some evidence that the beneficial effects of MBPs on 'burnout/fatigue' and 'non-judging' were lower in samples drawn from student populations relative to samples characterised as general population or working adults (see Table 1 for study characteristics). Details for the moderation analysis can be viewed in Tables S3 and S4 (online supplementary material).

Bias across studies

Asymmetric funnel plots and results from Egger's test suggested some small-study bias for the between-group analysis of 'describing' and the within-group analysis of 'stress/psychological distress' (see Table S5 and Funnel plots, online supplementary material). The sensitivity analysis showed that the omission of some studies would influence whether the overall effect for the between groups analysis of 'burnout/fatigue', 'rumination/worry' and 'describing' was considered significant. However, the confidence intervals did not change markedly. The inclusion of study quality as a moderator showed there were no significant associations between the overall effect size and study quality (see Table S5, online supplementary material).

Discussion

Our primary aim was to evaluate the effectiveness of MBSR and MBCT for psychological health and well-being in the general population. For the included studies that had also measured mindfulness, we had a secondary aim to evaluate whether or not MBSR and MBCT studies increased self-reported levels of mindfulness.

Our results showed that overall MBPs were effective for the reduction of depression, anxiety, rumination/worry, and stress/psychological distress; and for increasing quality of life/well-being, mindfulness (when operationalised as a unidimensional construct) and facets of mindfulness (observing, describing, acting with awareness, non-judging, non-reacting). These findings broadly align with previous systematic reviews and meta-analyses including studies whose samples were

drawn from clinical and non-clinical samples. For example, the effect sizes we found are similar to those generated in meta-analyses conducted in clinical samples (e.g., see Goldberg et al., 2018; Khoury et al., 2013; Piet & Hougaard, 2011) also suggesting that MBSR and MBCT could have utility in non-clinical samples. They are also similar to the effect sizes reported in meta-analyses conducted on studies of non-clinical samples (for reviews see, Chiesa & Serretti, 209; Eberth & Sedlemeier, 2012; Khoury et al., 2015; Virgili, 2015; Jayawardene et al., 2017; Lomas et al., 2018; Halladay et al., 2019).

Interestingly, the between-groups analysis showed that MBCT generated significantly larger effect sizes than MBSR for depression and anxiety; and that it was more effective for all included mindfulness outcomes, generating larger effect sizes than MBSR. This was the case irrespective of whether the outcomes were operationalised as a unidimensional construct (using a unidimensional scale or reporting and analysing only a total score for mindfulness), or as a multifaceted construct reporting and analysing the five different facets of mindfulness (describing, observing, acting with awareness, non-judging, and non-reacting). Increased levels of mindfulness have consistently been shown as a key mechanism of action for MBPs (see Alsubaie et al., 2017; Gu et al., 2015; van der Velden et al., 2015); and it might be that the cognitive components in MBCT enabled participants to embed their mindfulness learning more effectively thereby facilitating 'decentering' and subsequent increases in self-reported mindfulness skills. However, we exercise caution in our interpretation of these results because, while the effect sizes for MBCT were consistently larger than those for MBSR, the difference was only statistically significant in our between-group analysis for *depression* and *anxiety*, and in our within-group analysis for *mindfulness (total)* and the *describing* facet of mindfulness. Therefore, while the results of our meta-analysis are interesting and potentially show the superiority of MBCT, more research using this approach in non-clinical samples is needed in order to assess whether a more mature literature reflects our findings.

Given that all of our included studies were conducted in non-clinical adult samples, our findings suggest that MBSR and MBCT could be employed preventatively by reducing symptoms associated with poor mental health (e.g., depression, anxiety, burnout, fatigue, stress) and by

increasing positive mental health indices (e.g., improved quality of life or satisfaction with life). Much of the burden of disability in the population is attributable to sub-clinical symptoms of mental health disorder rather than to a diagnosed mental health condition (Judd et al., 2002); and people with sub-clinical symptoms of mental ill-health are at higher risk of developing diagnosable mental health conditions in the future (Sadek & Bona, 2000). If MBCT and MBSR can be operationalised effectively so that people within the *normal* part of the mental health distribution can access these programmes, they could form part of the wider public health agenda related to psychological health and well-being.

Even though we sought to include studies that had stated that had adhered closely to the standard protocols for MBSR or MBCT, many of the studies did not include sufficient details about the intervention for us to assess the veracity of this claim; and it was clear from our review that many had deviated from the standard protocol in some way. For example, some studies shortened the duration of their training and compressed content accordingly (e.g., Bartlett, Lovell, Otahal, & Sanderson, 2017; Bergen-Cico, Possemato, & Cheon, 2013; Jain et al., 2007; Josefsson, Lindwall, & Broberg, 2012; Luberto et al., 2017; Mackenzie, Poulin, & Seidman-Carlson, 2006; Pots, Meulenbeek, Veehof, Klungers, Bohlmeijer, 2014; Rosenweig, Reibel, Greeson, Brainard, & Hojat, 2003); other studies delivered their content in a non-standard way, i.e., via Group teleconference (Bazarko, Cate, Azocan, & Kreitzer, 2013), online/Internet (e.g., Krushe, Cyhlarova, King, & Williams, 2012; Mak, Chan, Cheung, Lin, & Ngai, 2015; Querstret, Cropley & Fife-Schaw, 2017, 2018; Spadaro & Hunker, 2016) or via self-help books (Lever-Taylor, Strauss, Cavanagh, & Jones, 2014); and many studies reduced the duration of weekly sessions from the standard 2.5 hours per week for MBSR or 2 hours per week for MBCT. The researchers made adjustments for pragmatic reasons (e.g., if conducted in the workplace so that employees did not have to take too much time out of their working day). What we need to understand is, does that matter? This presents an interesting avenue for future research.

Our analysis suggested that shorter training durations and lower intensity of training negatively impacted on effect sizes generated; however, well-designed RCTs evaluating 'original protocol' and 'adapted' MBSR and MBCT programs against each other are needed to establish whether this association is causal. Given that MBCT and MBSR programs are well-placed to be adapted for non-

clinical settings, it is important to establish the level of adaptation that is acceptable. Crane et al. (2017) have suggested that the emerging scientific exploration of MBPs will potentially be confounded by studies of programs cited as MBSR or MBCT, but that may deviate substantially from the original protocols thereby rendering them as something different. Where researchers deviate from the protocol for MBSR or MBCT, providing adequate details within the published paper will greatly aid the ability of the research community to develop a more nuanced mapping of the existing mindfulness intervention landscape.

On a related point, many published systematic reviews and meta-analyses do not stipulate the criteria by which mindfulness-based interventions reach the threshold for their parent study to be included in the review/meta-analysis, and it is difficult to then contextualise the findings in our meta-analysis accordingly. For example, two recent meta-analyses conducted in non-clinical populations (Lomas et al., 2018; Hallady et al., 2019) included interventions ranging from MBCT and MBSR to MBSR variants, mindful meditation, resilience training, stress management training, acceptance training, mindful meditation, body scan, hatha yoga, mindfulness for academic success, and meditation-based stress management (among others). These meta-analyses both found similar moderate effects sizes for (for example) depression and anxiety to those we found in the present meta-analysis; however, it is difficult to make comparisons regarding the relative merits and weaknesses of these reviews given the wide range of mindfulness-based and mindfulness-informed interventions included. This is not a criticism of these published reviews and meta-analyses and is linked to our previous point with regards to the proliferation of adapted mindfulness-informed programs currently being evaluated in both clinical and non-clinical settings.

Limitations and future research

The number of studies and the uneven distribution of studies across MBP approach and outcomes is a primary limitation of the current study, particularly as the random effects approach is more sensitive to the number of studies. As is always the case with meta-analyses, we were limited by the published literature and given the scope of the review we focused exclusively on studies published in peer-reviewed journals, that is, we did not include unpublished studies or dissertations. The

imbalance related to MBP approach may reflect the dominance of MBSR in non-clinical samples; however, with emerging evidence of growing use of MBCT in general population samples (e.g., Gallego et al., 2014; Krusche et al., 2012; Lever-Taylor et al., 2014; Luberto et al., 2017; Phang et al., 2016; Pots et al., 2014; Querstret et al., 2017, 2018; Raes, Dewulf, van Heeringen, & Williams, 2009; Ying, Zhaozhuo, Fung-Ying Siu, Xianglong, & Xinghua, 2018), greater equity in across MBP approaches may be evident in future reviews. In addition, for the purposes of generating reliable effect size estimates, related outcomes were collapsed (e.g., rumination and worry, fatigue and burnout, quality of life and well-being) which limited our ability to detect specific effects at the outcome level.

Several avenues for future research are evident. Firstly, is MBCT superior to MBSR for psychological health and well-being in the general population? The results in our review suggest that it might be. However, as we have highlighted above, we had an uneven distribution of MBP approach with a clear dominance of MBSR studies; therefore, future empirical studies are warranted employing RCT designs with treatment arms assessing MBSR and MBCT against each other in non-clinical samples. Furthermore, while our review suggested that some intervention implementation characteristics (e.g., duration of intervention, total training time) may impact on effectiveness of MBSR- and MBCT-based interventions in practice, further research is warranted with RCT designs to assess the most meaningful moderators against each other (e.g., does mode of delivery have a significant impact?). We still do not know what the ideal protocol is and in order to increase accessibility of psychological interventions to a wider proportion of the community (e.g., by operationalising interventions online), we need to be able to understand under what conditions, and for whom, an intervention is most effective; and also, any contraindications for these types of interventions in the community/general population. As the people who volunteer to take part in mindfulness-based intervention studies may have certain and specific characteristics, the results may not generalise more broadly to those who do not share these characteristics; therefore, future research could explore these characteristics. In service of these latter research avenues, using a realist evaluation approach (Pawson & Tilley, 1997; Wong et al., 2016) to intervention design, development, implementation and evaluation would help to uncover how the intervention works, for whom, and

under what circumstances. A strength of this approach is that it enables contextual and individual factors to be considered providing greater depth of understanding with regards to intervention effectiveness enabling a more nuanced approach to intervention design in different contexts (e.g., across different types of organisations).

Conclusions

This study provides evidence that in non-clinical samples, MBPs are associated with benefits to health and well-being as well as increased levels of mindfulness. These findings add to the growing evidence-base suggesting that MBSR and MBCT may be effective approaches for sub-clinical levels of mental ill-health and could form part of the public mental health agenda. MBCT consistently gave the largest effect sizes across the range of psychological health and well-being outcomes included in our study, and was significantly more effective than MBSR for reducing symptoms of depression and anxiety. However, further research is needed with well-designed RCTs to explore the relative effectiveness of different MBPs for psychological health and well-being in the general population; and a greater understanding of the impact of adapting MBPs for different contexts is also warranted.

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Figure 1. PRISMA flow diagram

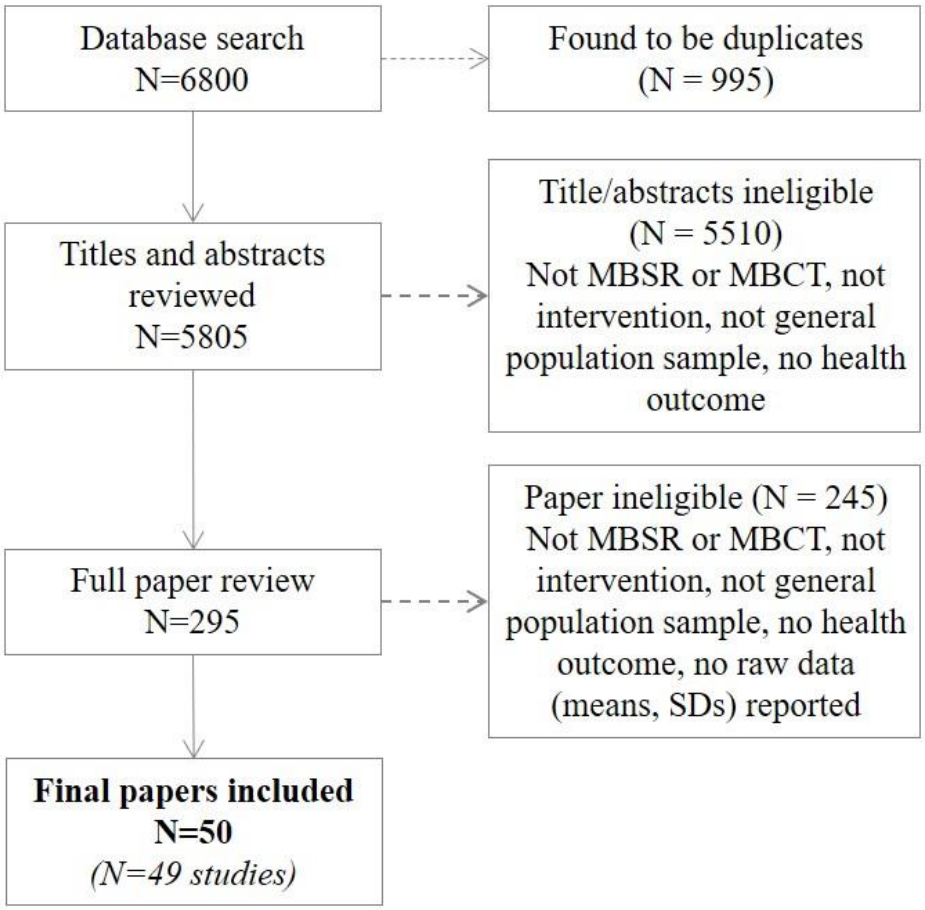

Table 1. Study demographics, psychological constructs and measures

No.	Study	Sample (N) Country	Mean age % women	Study design	MBP (n)	Other (n)	Timepoints	Psychological Construct/s (self-report measure)
1	Aikens et al., 2014	Working adults (89) USA	Not reported	RCT	MBSR (44)	WLC (45)	Baseline; 7-weeks; 6-mths (FU)	Stress (PSS-10); Mindfulness: Obs; Des; AA; NJ; NR (FFMQ)
2	Allexandre et al., 2016	Working adults (81) USA	40, 83.2%	RCT	MBSR group (26) MBSR online (30)	WLC (25)	Baseline; 8-weeks; 4- & 12-mths (FU)	Stress (PSS-10); Burnout/Fatigue (MBI); QoL/well-being (SF-36); AA (MAAS)
3	Bartlett et al., 2017	Working adults (121) Australia	Not reported, 95%	RCT	MBSR (20)	CTL (100)	Baseline; 6-weeks	Stress (PSS-10); AA (MAAS); QoL/well-being (AQoL-4D)
4	Bazarko et al., 2013	Working adults (36) USA	52.2, 100%	Pre-post	MBSR	n/a	Baseline; 8-weeks	Stress (PSS-10); Burnout/fatigue (CBI)
5	Bergen-Cico et al., 2013	Students (119) USA	30.1, 76%	Quasi	MBSR (72)	CTL (47)	Baseline; 6-weeks	Anxiety (STAI); Obs, Des, AA, NJ (KIMS)
6	Birnie et al., 2010	Community (104) Canada	47.4, 69%	Pre-post	MBSR (104)	n/a	Baseline; 8-weeks	Stress (SOSI); AA (MAAS)
7	Canby et al., 2015	Students (44) USA	21.25, 68%	Quasi	MBSR (19)	CTL (25)	Baseline; 6-weeks	Stress (BSI); AA (MAAS)
8	Collard et al., 2008	Students (15) UK	24 – 56, 80%	Pre-post	MBCT	n/a	Baseline; 8-weeks	Mindfulness (FMI); QoL / Well-being (SWLS)
9	De Vibe et al., 2013	Students (288) Norway	23.8, 76%	RCT	MBSR (144)	CTL (144)	Baseline; 7-weeks	Burnout/ Fatigue (MBI); Stress (PMSS); QoL/ Well-being (SWB); Ob, Des, AA, NJ, NR (FFMQ)
10	Dobie et al., 2013	Working adults (9) Australia	Not reported	Pre-post	MBSR	n/a	Baseline; 8-weeks	Depression, Anxiety, Stress (DASS)
11	Dobkin et al., 2015	Working adults (27) France	46.7, 76%	Pre-post	MBSR (27)	n/a	Baseline; 8-weeks	Stress (PSS-10); Depression (BDI); Burnout/ Fatigue (MBI); AA, NR, NJ (FFMQ)
12	Erogul et al., 2014	Students (59) USA	23.45, 45.6%	RCT	MBSR (29)	CTL (30)	Baseline; 8-weeks 6-mth (FU)	Stress (PSS-10)
13	Galantino et al., 2005	Working adults (84) USA	43, 96%	Pre-post	MBCT	n/a	Baseline; 8-weeks	Burnout/ Fatigue (MBI); Anxiety & Depression (POMS)

14	Gallego et al., 2014	Students (125) Spain	20, 57.6%	RCT	MBCT (41)	PA (42) CTL (42)	Baseline; 8-weeks	Anxiety, Depression & Stress (DASS)
15	Gawrysiak et al., 2015	Community (258) USA	48.9, not reported	Pre-post	MBSR	n/a	Baseline; 8-weeks	Stress (PSS-10); Depression & Burnout/ Fatigue (POMS)
16	Geary et al., 2011	Working adults (153) USA	45, 90.5%	RCT	MBSR (59)	CTL (94)	Baseline; 10-weeks	Stress (PSS-10); QoL/ Well-being (SF-36)
17	Goodman & Schorling 2012	Working adults (93) USA	Not reported, 65%	Pre-post	MBSR	n/a	Baseline; 8-weeks	Burnout/ Fatigue (MBI)
18	Greeson et al., 2015	Community (322) USA	42, 73.9%	Pre-post	MBSR	n/a	Baseline; 8-weeks	Depression (HADS)
19	Hou et al., 2013	Community (141) Hong Kong	57.5, 83.7%	RCT	MBSR (70)	CTL (71)	Baseline; 8-weeks	Depression (CESD); Anxiety (STAI); Stress (PSS-10); QoL/ Well-being (SF-12); Mindfulness (FFMQ)
20	Jain et al., 2007	Students (141) USA	25, 77%	RCT	MBSR (27)	CTL (30) Relax (24)	Baseline; 4-weeks	Stress (BSI); Rumination (DERS)
21	Josefsson et al., 2012	Working adults (126) Sweden	48.2, 91.6%	RCT	MBSR (40)	WLC (46) Relax (40)	Baseline; 4-weeks	Anxiety & Depression (HADS); QoL/Well-being (SPWB); Obs, Des, AA, NJ, NR (FFMQ)
22	Kaplan et al., 2017	Working adults (69) USA	43.5, 57%	Pre-post	MBSR	n/a	Baseline; 8-weeks	Burnout/ Fatigue (OLBI); AA, NJ, NR (FFMQ);
23	Klatt et al., 2017	Working adults (42) USA	44.95, 75%	RCT	MBSR (22)	WLC (20)	Baseline; 6-weeks	Stress (PSS-10); AA (MAAS)
24	Krusche et al., 2012	Community (100) UK	48, 74%	Pre-post	MBCT	n/a	Baseline; 6-weeks; 3-mths (FU)	Stress (PSS-10)
25	Lever Taylor et al., 2014	Students (80) UK	28.61, 81%	RCT	MBCT (40)	WLC (39)	Baseline; 8-weeks	Anxiety, Depression, & Stress (DASS); Obs, Des, AA, NJ, NR (FFMQ)
26	Lo et al., 2017	Community (180) Hong Kong	38.85, 94%	RCT	MBSR (91)	CTL (89)	Baseline; 6-weeks	Depression (CESD)
27	Luberto et al., 2017	Working adults (65) USA	44.06, 86%	Pre-post	MBCT	n/a	Baseline; 4-weeks	Stress (PSS-10); Burnout/ Fatigue (Single item)[a]

28	Mackenzie et al., 2006	Working adults (30) Canada	46.7, 96.7%	RCT	MBSR (16)	CTL (14)	Baseline; 4-weeks	Burnout/ Fatigue (MBI); QoL/ Well-being (SWLS)
29	Mahon et al., 2017	Working adults (64) Ireland	44.16, 99%	Pre-post	MBSR	n/a	Baseline; 8-weels	Stress (PSS-10)
30	Mak et al., 2015	Working adults (164) Hong Kong	22.8, 66.3%	RCT	MBSR (58)	WLC (48) HAPA (58)	Baseline; 8-weeks; 3-mth (FU)	Stress (PSS-10); Anxiety & Depression (DASS); QoL/ Well-being (WHO-WBI); Obs, Des, AA, NJ, NR (FFMQ)
31	Martin-Asuero et al., 2010	Working adults (29) Spain	41.10, 83%	Pre-post	MBSR	n/a	Baseline; 8-weeks	Stress (SRLE); Rumination (ECQ)
32	Minor et al., 2006	Community (44) Canada	Not reported, 86.4%	Pre-post	MBSR	n/a	Baseline; 8-weeks	Stress (SOSI); Anxiety & Depression (POMS)
33	Montero-Marin et al., 2018	Working adults (58) Spain	49.01, 77.5%	Pre-post	MBSR	n/a	Baseline; 4-weeks	AA (MAAS); Burnout/ Fatigue (BCSQ-12)
34	Nyklicek & Kuijpers, 2008	Community (60) Netherlands	46, 67%	RCT	MBSR (28)	WLC (29)	Baseline; 8-weeks	Stress (PSS-10); Burnout/ Fatigue (MQ); QoL/ Well-being (WHOQol-bref)
35	Phang et al., 2015	Students (135) Malaysia	22.23, 62%	Pre-post	MBCT	n/a	Baseline; 5-weeks	Stress (PSS-10); AA (MAAS)
36	Pots et al., 2014	Community (151) Netherlands	47.94, 77.35%	RCT	MBCT (76)	WLC (75)	Baseline; 12-weeks; 6-mth (FU)	Depression (CESD); Anxiety (HADS); Obs, Des, AA, NJ, NR (FFMQ)
37	Poulin et al., 2008	Working adults (40) Canada	47.3, 86.9%	Quasi	MBSR (16)	IPMR (10) CTL (14)	Baseline; 4-weeks	Burnout/ Fatigue (MBI); QoL/ Well-being (SWLS)
38	Querstret et al., 2017; 2018	Working adults (118) UK	40.66, 80.5%	RCT	MBCT (60)	WLC (58)	Baseline; 4-weeks; 3- & 6-mth (FU)	Stress (PSS-10); Depression (PHQ-9); Anxiety (GAD-7); Rumination (WRRQ); Burnout/ Fatigue (OFER); Des, AA, NJ, NR (FFMQ)
39	Raes et al., 2009	Community (39) Belgium	41.75, 84.2%	RCT	MBCT (18)	WLC (21)	Baseline; 8-weeks	Mindfulness (KIMS); Depression (BDI)
40	Robins et al., 2012	Community (56) USA	45.05, 83.1%	RCT	MBSR (28)	WLC (28)	Baseline; 8-weeks; 2-mth (FU)	Rumination (RRS); Worry (PSWQ); Mindfulness (FFMQ)
41	Rosenzweig et al., 2003	Students (302) USA	Not reported	CT	MBSR (140)	CTL (162)	Baseline; 10-weeks	Anxiety & Depression & Burnout/ Fatigue (POMS)

42	Roulston et al., 2018	Students (25) UK	29, 83.33%	CT	MBSR (13)	CTL (12)	Baseline; 6-weeks	Stress (PSS-10); QoL/ Well-being (WEMWBS)
43	Shapiro et al., 2011	Students (30) USA	18.73, 86.7%	RCT	MBSR (15)	CTL (15)	Baseline; 8-weeks; 2- & 12-mths (FU)	Stress (PSS-10); Rumination (RRQ); QoL/ Well-being (SWLS); AA (MAAS)
44	Song & Lindquist, 2015	Students (44) South Korea	19.55, 81.8%	RCT	MBSR (21)	WLC (23)	Baseline; 8-weeks	Anxiety, Depression, & Stress (DASS); AA (MAAS)
45	Spadaro & Hunker, 2016	Students (26) USA	Not reported	Pre-post	MBSR	n/a	Baseline; 8-weeks; 4-mth (FU)	Stress (PSS-10); Anxiety & Depression (HADS)
46	Trowbridge et al., 2017	Working adults (26) USA	Not reported	Pre-post	MBSR	n/a	Baseline; 6-weeks	Stress (PSS-10); AA (MAAS); Burnout/ Fatigue (ProQOL)
47	Van Dijk et al., 2017	Students (167) Netherlands	23.5, 78.5%	RCT	MBSR (83)	CTL (84)	Baseline; 12-weeks; 7-, 12-, 15-, 20-mth (FU)	Psych distress (BSI); Mindfulness (FFMQ)
48	Whitebird et al., 2012	Community (78) USA	56.8, 88.3%	RCT	MBSR (38)	CCES (40)	Baseline; 8-weeks; 6-mth (FU)	Stress (PSS-10); Depression (CESD); Anxiety (STAI)
49	Ying et al., 2018	Community (76) China	27.94; 57.8%	RCT	MBCT group (online) (20); MBCT self-help (15)	Discussion group (18); CTL (23)	Baseline; 8-weeks	Mindfulness (FFMQ); Anxiety (SAS); Depression (SDS)

MBP = Mindfulness-Based Program, Other = comparator group/s; **Sample:** Community = convenience sample drawn from the general population, Students = university students; **Study design:** RCT = Randomised Control Trial, Quasi = Quasi-experimental; **MBPs:** MBSR = Mindfulness-Based Stress Reduction, MBCT = Mindfulness-Based Cognitive Therapy; **Comparator:** PMR = Progressive Muscle Relaxation; WLC = Waitlist Control; CTL = Control Group; Relax = Relaxation; HAPA = Health Action Process Approach; PA = Physical Activity; IPMR = Imagery and Progressive Muscle Relaxation; CCES = Community Caregiver Education and Support; **Psychological Constructs:** AA = Acting with Awareness; OBS = Observing; DES = Describing; NJ = Non-judging; NR = Non-reacting; TOT = Total score; QoL = Quality of Life; **Measures:** [a]Non-validated measure; AQoL-4D = Assessment of Quality of Life; BCSQ-12 = Burnout Clinical Subtype Questionnaire; BDI = Beck's Depression Inventory; BSI = Brief Symptom Inventory; CBI = Copenhagen Burnout Inventory; CESD = Centre for Epidemiologic Depression Scale; DASS = Depression Anxiety Stress Scales; DERS = Daily Emotion Report Scale; ECQ = Emotional Control Questionnaire; FFMQ = Five Factor Mindfulness Questionnaire; GAD-7 = Generalised Anxiety Disorder Assessment 7-items; FMI = Freiberg Mindfulness Inventory; HADS = Hospital Anxiety and Depression Scale; KIMS = Kentucky Inventory of Mindfulness Skills; MAAS = Mindfulness Attention Awareness Scale; MBI (exhaustion) = Maslach Burnout Inventory; MQ = Maastricht Questionnaire; OLBI = Oldenburg Burnout/Fatigue Inventory; OFER = Occupational Fatigue Recovery Scale; PHQ-9 = Patient Health Questionnaire 9-items; PMSS = Perceived Medical School Stress; POMS = Profile of Mood States; ProQOL = Professional Quality of Life; PSS-10 = Perceived Stress Scale; PSWQ = Penn State Worry Questionnaire; PWS: Psychological Well-being Scale; RRQ - Rumination Reflection Questionnaire; RRS = Rumination Response Scale; SAS = Self-rating Anxiety Scale; SDS = Self-rating Depression Scale; SF-12 = Short from of the Health Survey; SF-36 = Short Form-36; SOSI = Symptoms of Stress Inventory; SRLE = Survey of Recent Life Experiences; STAI = State Trait Anxiety Inventory; SWB = Subjective Well Being; SWLS = Satisfaction with Life Scale; SPWB = Scales of Psychological Well-being; WHOQol_Bref = World Health Organisation Quality of Life; WHO-WBI = World Health Organisation Well-being Index; WBMWBS = Warwick-Edinburgh Mental Well-being Scale; WRRQ = Work-Related Rumination Questionnaire; n/a = Not applicable; FU = Follow-up.

Table 2. Combined effect estimates (Hedges g) overall and by MBI type (MBSR, MBCT) for psychological health and well-being outcomes

	Between-group: MBI vs (Non-active) control					Within-group: Pre- vs. Post-MBI				
		Effect size		Heterogeneity			Effect size		Heterogeneity	
	N	*g* (95%CI)	p	I^2	p(Q)	N	*g* (95%CI)	p	I^2	p(Q)
Stress/ Psych Distress										
Overall	20	-.52 (-.68, -.36)	<.001	58.4	.001	35	-.99 (-1.18, -.81)	<.001	83.8	<.001
MBSR	17	-.45 (-.59, -.30)	<.001	43.9	.027	29	-1.00 (-1.21, -.78)	<.001	84.5	<.001
MBCT	3	-.82 (-1.26, -.38)	<.001	68.5	.042	6	-1.00 (-1.37, -.64)	<.001	82.4	<.001
Difference			.073					.966		
Depression										
Overall	13	-.45 (-.64, -.26)	.001	64.6	.001	20	-.55 (-.69, -.41)	<.001	60.4	<.001
MBSR	6	-.22 (-.38, -.06)	.006	23.0	.261	13	-.46 (-.61, -.31)	<.001	55.0	.009
MBCT	7	-.66 (-.90, -.43)	<.001	42.1	.110	7	-.76 (-1.04, -.48)	<.001	55.7	.035
Difference			.013					.070		
Anxiety										
Overall	12	-.44 (-.65, -.23)	<.001	69.1	<.001	16	-.47 (-.64, -.31)	<.001	57.1	.002
MBSR	6	-.19 (-.33, -.05)	.008	0	.420	10	-.36 (-.49, -.22)	<.001	10.7	.344
MBCT	6	-.72 (-.97, -.46)	<.001	47.0	.093	6	-.61 (-.96, -.25)	.001	71.6	.003
Difference			.005					.168		
Burnout/ Fatigue										
Overall	8	-.20 (-.43, .03)	.091	58.6	.018	18	-.49 (-.69, -.29)	<.001	77.2	<.001
MBSR	7	-.13 (-.34, .09)	.247	43.7	.100	16	-.46 (-.67, -.24)	<.001	77.7	<.001
MBCT	1	-.65 (-1.02, -.28)	.001	-	-	2	-.77 (-1.11, -.44)	<.001	25.4	.247
Difference			.145					.273		
Rumination/ Worry										
Overall	5	-1.13 (-2.17, -.08)	.034	93.1	<.001	6	-.56 (-.84, -.27)	<.001	38.3	.151
MBSR	2	-2.48 (-5.93, .97)	.159	96.9	<.001	3	-.36 (-.69, -.03)	.034	0	.634
MBCT	3	-0.37 (-.65, -.09)	.010	0	.772	3	-.72 (-1.15, -.29)	.001	47.9	.147
Difference			.201					.208		
QoL/ Well-being										
Overall	12	.32 (.10, .54)	.005	65.2	.001	13	.56 (.38, .74)	<.001	45.1	.039
MBSR	12	.32 (.10, .54)	.005	65.2	.001	12	.57 (.38, .76)	<.001	49.4	.027
MBCT	0	-	-	-	-	1	.38 (-.34, 1.11)	.296	-	-
Difference			-	-				.683		

MBI = Mindfulness-Based Intervention; MBSR = Mindfulness-Based Stress Reduction; MBCT = Mindfulness-Based Cognitive Therapy; N = the number of studies; *g* = Hedges' g; I^2 = the variation in g attributable to heterogeneity; p(Q) = p-value for test that all studies share same effect size; The p-value for the difference between MBI types adopts the Knapp-Hartung modification; QoL = Quality of Life.

Table 3. Combined effect estimates (Hedges' *g*) overall and by MBI type (MBSR, MBCT) for Mindfulness outcomes

	Between-group: MBI vs (Non-active) control					Within-group: Pre- vs. Post-MBI				
		Effect size		Heterogeneity			Effect size		Heterogeneity	
	N	*g* (95%CI)	p	I^2	p(Q)	N	*g* (95%CI)	p	I^2	p(Q)
Acting with Awareness										
Overall	17	.31 (.08, .54)	.007	75.7	<.001	23	.60 (.43, .77)	<.001	71.1	<.001
MBSR	11	.20 (-.04, .44)	.105	71.4	<.001	19	.56 (.35, .76)	<.001	73.2	<.001
MBCT	4	.68 (.41,.96)	<.001	35.7	.211	4	.72 (.56, .89)	<.001	0	.405
Difference			.100					.325		
Describing										
Overall	8	.20 (.03, .36)	.018	40.2	.111	9	.24 (.11, .38)	<.001	21.3	.254
MBSR	5	.20 (-.06, .46)	.126	62.4	.031	6	.14 (-.01, .28)	.063	0	.579
MBCT	3	.22 (.01, .43)	.041	0	.716	3	.46 (.24, .67)	<.001	0	.800
Difference			.858					.045		
Observing										
Overall	8	.46 (.24, .68)	<.001	63.5	.008	9	.45 (.25, .63)	<.001	57.2	.017
MBSR	6	.41 (.14, .68)	.003	66.4	.011	7	.39 (.15, .64)	.002	59.6	.022
MBCT	2	.62 (.25, .99)	.001	44.3	.180	2	.63 (.36, .89)	<.001	0	.733
Difference			.432					.337		
Non-judging										
Overall	9	.25 (.10, .41)	.002	38.5	.112	12	.45 (.27, .64)	<.001	60.9	.003
MBSR	6	.16 (0, .32)	.050	12.0	.338	9	.34 (.16, .52)	<.001	43.3	.079
MBCT	3	.40 (.11, .69)	.008	45.3	.160	3	.72 (.38, 1.05)	<.001	56.3	.101
Difference			.203					.076		
Non-Reacting										
Overall	7	.53 (.28, .78)	<.001	69.5	.003	10	.72 (.47, .98)	<.001	74.2	<.001
MBSR	4	.37 (.10, .64)	.007	56.7	.074	7	.65 (.32, .98)	<.001	77.3	<.001
MBCT	3	.75 (.38, 1.11)	<.001	63.1	.066	3	.89 (.67, 1.11)	<.001	0	.675
Difference			.182					.397		
Mindfulness (Total)										
Overall	11	.53 (.35, .71)	<.001	37.0	.103	13	.50 (.30, .69)	<.001	48.8	.024
MBSR	6	.44 (.22, .65)	<.001	42.3	.123	7	.30 (.15, .45)	<.001	2.00	.410
MBCT	5	.73 (.47, .99)	<.001	0	.493	6	.88 (.62, 1.14)	<.001	0	.707
Difference			.156					.003		

MBI = Mindfulness-Based Intervention; MBSR = Mindfulness-Based Stress Reduction; MBCT = Mindfulness-Based Cognitive Therapy; N = the number of studies; *g* = Hedges' g; I^2 = the variation in g attributable to heterogeneity; p(Q) = p-value for test that all studies share same effect size; The p-value for the difference between approaches adopts the Knapp-Hartung modification.