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An Overview of the Research on Mindfulness Based Interventions for Treating Symptoms of Post-traumatic Stress Disorder

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Abstract

Objective: This systematic review aimed to collate and evaluate the existing research for the use of mindfulness based approaches to treat post-traumatic stress disorder. Primary objectives were to explore the effects of mindfulness based approaches on post-traumatic stress symptoms and associated psychological distress; with secondary objectives to explore the attrition rate, adverse effects, resource implications and long term effects of such interventions.

Method: Research databases, EMBASE, OVID MedLine, Psycinfo, CINAHL and PILOTS were systematically searched, relevant authors in the field were contacted and a hand search of relevant papers was conducted.

Results: The search resulted in 12 studies that met eligibility criteria. Many of these studies lacked methodological rigour. The majority of studies indicated positive outcomes with improvements in post-traumatic stress symptoms, particularly in reducing avoidance.

Conclusions: The preliminary evidence for the use of mindfulness based approaches to treat post-traumatic stress symptoms is encouraging, although further studies with more robust research design are required.

An Overview of the Research on Mindfulness Based Interventions for Treating Symptoms of Post-traumatic Stress Disorder: A Systematic Review.

Post-traumatic stress disorder (PTSD) is defined as a presentation of characteristic symptoms following direct exposure, witnessing or learning of an event that involves actual or threatened death or serious injury or harm to self or others (American Psychiatric Association, 2013). PTSD is characterised by four clusters of symptoms which can be summarised as- re-experiencing traumatic events which may occur through flashbacks or nightmares, negative cognitions and mood, avoidance of trauma related cognitions and triggers which may present as dissociation or emotional numbing; and hyper arousal such as, hyper-vigilance to threat, irritability and sleep problems (APA, 2013). PTSD symptoms can be variable in terms of impact, severity, and duration; many researchers have suggested that a chronic form of complex PTSD may occur following prolonged or repeated traumatic events (Cloitre et al., 2009). PTSD is a significant health issue: it has been estimated that 25-30% of people who experience a traumatic life event go on to develop PTSD (National Institute Clinical Excellence, 2005). A recent study highlighted the high prevalence rate of trauma symptoms amongst mental health service users: 89% of a representative sample of individuals referred to primary care psychology reported exposure to traumatic life events and 51% met the screening criteria for PTSD despite trauma not always being the primary reason for referral (Noel, Gillanders & Power, 2012).

PTSD Interventions

The cognitive model of PTSD largely dominates the literature and is one of the most pervasive models for conceptualizing the development and maintenance of this disorder (Ehlers & Clark, 2000). The model proposes two main perpetuating factors which lead to a perceived sense of current threat: negative appraisals of the traumatic events and disrupted processing of trauma

memories through avoidance. The cognitive model has informed the main approaches for intervention such as Prolonged Exposure (PE), Cognitive Behavioural Therapy (CBT), and neurobiological approaches such as Eye Movement Desensitisation and Reprocessing (EMDR). There is a significant evidence base for these approaches and the effectiveness of these interventions has been well documented (Powers, Halpern, Ferenschak, Gillihan & Foa, 2010; Mendes, Mello, Venture, Passarela & Mari, 2008; Seidler & Wagner, 2006). However attrition rates for these treatments are often high; a review of 55 empirical studies of CBT and EMDR found that it was not uncommon for drop-out rates to be as high as 50% (Schottenbauer, Glass, Arnkoff, Tendick & Gray, 2008). Clinical trials have also shown that a subgroup of PTSD patients may not benefit from CBT or PE approaches, and a substantial amount of participants have residual PTSD symptoms post treatment (Bradley, Greene, Russ, Dutra & Westen, 2005). Becker, Zayfert and Anderson (2004) surveyed 852 psychologists working with trauma, and found that exposure techniques were highly under-utilized and widely unaccepted in clinical practice; this was due to a reported lack of training or experience and perceptions about contraindications of using exposure, including increased symptoms of dissociation, re-experiencing, anger and suicidality. Therefore it is important that interventions are further developed to ensure they are acceptable and feasible for implementation in clinical practice and effective for the majority of individuals.

Previous diagnostic criteria for PTSD characterized it as an anxiety disorder and therefore interventions have traditionally focused on exposure techniques (APA, 2000). However the diagnostic criteria for PTSD have been updated to include the presence of negative cognitions and mood which reflects the wide range of different emotions, besides anxiety, that may be experienced as part of PTSD (APA, 2013). It is recognised that the emotions experienced by

individuals with PTSD may be variable, depending on the type of traumatic event experienced (Amstadter & Vernon, 2008). A recent study found that in a representative sample of people with PTSD referred to a trauma clinic, less than 50% experienced anxiety as their primary emotion and the rest experienced sadness, disgust or anger as their primary emotion; the use of exposure techniques were significantly less effective for the non- anxiety based PTSD group (Power & Fyvie, 2013). This is an important finding for individuals who experience emotions other than anxiety following traumatic events as exposure therapy may not be effective, and may even attenuate negative emotions. Consequently, it is important for interventions to be further developed and researched to address symptoms of negative cognitions and mood. Therapies such as Cognitive Processing Therapy (CPT) have been shown to be more effective than exposure techniques for treating PTSD particularly for reducing guilt cognitions (Resick, Nishith, Weaver, Astin & Feuer, 2002). CPT has also indicated effectiveness in working with symptoms of anger, guilt, shame and cognitive distortion including self-blame in trauma survivors (Resick, Galovski, Uhlmansiek, Scher, Clum, & Young-Xu, 2008).

Emotions such as shame are an important contributing factor for the development and maintenance of PTSD (Leskela, Dieperink & Thuras, 2002). Lee, Scragg and Turner (2001) have proposed a clinical model for shame based, and guilt based, PTSD. The authors propose that emotions such as guilt, shame and humiliation perpetuate PTSD symptoms and give a sense of current threat through attacking personal integrity. They suggest that high levels of guilt and shame prevent individuals from presenting to services for treatment and may contribute to early drop-out from therapy (Lee et al., 2001). Shame is an emotion that is characterized by harsh judgment of oneself and the use of avoidance and self-criticism as safety behaviors (Gilbert, 2009). One technique which has been applied to reduce avoidance whilst acknowledging

difficult emotions and thoughts in a non-judging manner is mindfulness. Mindfulness is an approach which aims to increase acceptance therefore may be useful for working with negative cognitions such as self-blame and negative mood, including shame or guilt.

Mindfulness

Mindfulness is described as ‘the awareness that emerges through paying attention on purpose, in the present moment, and non-judgmentally to the unfolding of experience moment by moment’ (Kabat-Zinn, 2003, p.145). Mindfulness therefore promotes mental wellbeing by changing the relationship individuals have with their thoughts, increasing the ability to observe thoughts and emotions in an accepting way. Mindfulness has been widely researched in psychiatric, physical health, and healthy populations (Baer, 2003). Meta-analytic studies have shown mindfulness based approaches to be effective for stress reduction (Chiesa & Serretti, 2009) and for anxiety and depression (Hofmann, Sawyer, Witt & Oh, 2010). Mindfulness practice originates from Buddhism, although mindfulness techniques have been integrated with western approaches. Mindfulness has been incorporated into a number of so called ‘third wave’ therapeutic approaches including Mindfulness Based Stress Reduction (MBSR), Mindfulness Based Cognitive Therapy (MBCT), Acceptance and Commitment Therapy, and Dialectical Behaviour Therapy (Baer, 2003).

The most commonly cited mindfulness approach is Mindfulness Based Stress Reduction (MBSR). MBSR is delivered in a group setting over 8 weekly sessions lasting 2-2.5 hours each, with a full day session around week 6. The intervention is multifaceted and consists of mindfulness meditation, experiential exercises, Hatha yoga, discussion about stress and coping, and regular homework tasks including daily practice of mindfulness (Kabat-Zinn, 1990). Mindfulness Based Cognitive Therapy (MBCT) is based on MBSR, although incorporates a

cognitive component; focus is placed on being more aware of thoughts and feelings with an emphasis on changing the relationship an individual has with their thoughts rather than changing or challenging the content of the thoughts (Segal, Williams & Teasdale, 2012). MBCT was developed originally as an intervention for recurring depression, and is a manualised program of 8 weekly classes plus 1 all day session.

Mindfulness and PTSD

Mindfulness has recently received increased attention within the research on PTSD. Theoretical reviews have outlined the argument for use of mindfulness techniques as a means of reducing avoidance, aiding emotion regulation and increasing distress tolerance in traumatized individuals (Follette, Palm & Pearson, 2006). It has been hypothesised that mindfulness may therefore be a useful addition to existing interventions such as CBT or PE (Follette et al., 2006). Research has shown that an individual's ability to be mindful is predictive of PTSD symptoms; in a study of 124 urban firefighters increased mindfulness was associated with fewer symptoms of PTSD, and lower levels of depression (Smith et al., 2011). In particular the mindful concept of non-judgment of experience has been shown to account for a unique proportion of the variance in PTSD avoidance symptoms (Thomson & Waltz, 2010). Similarly another study found that when controlling for negative affect and the extent of trauma exposure the mindful concept of accepting thoughts without judgment was significantly associated with symptoms of PTSD (Vujanovic, Youngwirth, Johnson & Zvolensky, 2009). It may be that teaching of mindfulness techniques is related to reducing judgment and overcoming avoidance, which may allow for further psychological therapeutic work to progress. This emerging literature seems to suggest that taking a mindful, non-judgmental stance towards traumatic experiences could reduce traumatic stress symptoms.

There is an alternative argument that mindfulness based approaches may exacerbate trauma symptoms. It has been suggested that bringing awareness to the present moment and reducing avoidance may trigger distressing flashbacks or intrusive thoughts and memories (Lustyk, Chawla, Nolan & Marlatt, 2009). A review of the literature exploring the adverse effects of mindfulness meditation (MM) found that in some studies MM actually increased experiences of depersonalisation and derealisation, and may therefore lead to greater experiences of dissociation in individuals with PTSD; the authors of this review suggest that MM should only be practiced with this population under supervision or by adequately trained experienced practitioners so that any potential adverse effects can be monitored and controlled (Lustyk et al., 2009). Dutton, Bermemudez, Matas, Majad & Myers (2011) studied the feasibility of MBSR for individuals with PTSD by conducting focus groups with residents of domestic violence shelters; the qualitative feedback highlighted concerns about mindfulness techniques, particularly discomfort with having to lie down, close one's eyes and focus on body sensations. They adapted a mindfulness intervention using sitting meditations with eyes open as an alternative and there was positive qualitative feedback for the intervention (Dutton et al., 2011). It may be that mindfulness approaches are more accessible for this population when tailored to meet individual needs and when appropriately supervised.

Current Review

A systematic review of mind-body approaches for PTSD was published in 2013; this review incorporated interventions such as yoga, MBSR, meditation, tai chi and qigong (Kim, Schneider, Kravitz, Mermier & Burge, 2013). The review identified 16 relevant studies (6 Randomized Controlled Trials), the majority of which reported improvements in stress, depression and PTSD symptoms. Improvements were largely sustained in studies which reported long term follow up

ranging between 3-15 months. This previous review involved adolescent and adult samples, and included 3 studies of mindfulness based interventions; since that time there has been a rapid increase in the published studies examining mindfulness based approaches for PTSD. The existing empirical research about mindfulness based interventions with PTSD has not yet been reviewed systematically. This current systematic review aimed to review the existing quantitative evidence for the use of mindfulness based interventions in reducing symptoms of PTSD in adults. The secondary aims of this review were to consider the resource implications of mindfulness based approaches in PTSD, explore the attrition rates of such interventions and to consider any adverse reactions to treatment.

Methods

The systematic search of the literature was conducted during October 2014. The databases searched included Psycinfo (1806 to October, week 2, 2014), Embase (1980 to 2014 week 41), OVID Medline (1946 to October, week 2, 2014), Published International Literature on Traumatic Stress (PILOTS) (1871- current) and the Cumulative Index to Nursing Allied Health Literature (CINAHL Plus). Psycinfo, Embase and OVID Medline were searched with the terms 'PTSD' OR 'post traumatic stress disorder' OR 'posttraumatic stress disorder' OR 'traumatic stress' AND 'mindful*'. PILOTS was searched with the term 'mindful*'. CINAHL was searched with the terms 'stress disorders, post-traumatic' AND 'mindfulness'. Relevant reviews and publications were hand searched and contributors in the field were contacted about ongoing and unpublished work.

Selection Criteria

The eligibility criteria for this review were determined by initially forming a working definition of the term mindfulness based intervention. Mindfulness practice is multifaceted and

may consist of multiple components, including meditation, experiential exercises, breathing and movement. Kabat-Zinn states '(mindfulness) is not limited to the operationalization of particular techniques... they are the menu, so to speak, not the meal' (Kabat-Zinn, 2003 p147). Several studies focus on one aspect of mindfulness, particularly teaching one particular form of meditation. For the purpose of this review mindfulness based approaches will exclude approaches which focus on specific types of meditation alone i.e. transcendental, mantram based, loving kindness. As the aim of this review was to explore the existing research on mindfulness based approaches for treating PTSD symptoms, only studies which used an objective, standardised measure of PTSD symptoms were included, therefore it was out-with the scope of this current review to include qualitative studies.

Studies were selected that met the following inclusion criteria-

- Intervention that is mindfulness based.
- Adult sample aged ≥ 18 years.
- Used a reliable and validated outcome measure of PTSD pre and post intervention.
- Published in English.

Studies were excluded according to the following exclusion criteria-

- Mixed intervention studies i.e. mindfulness combined with PE, CBT, EMDR.
- Used only specific types of meditation- transcendental, loving kindness, mantram based.
- Used qualitative analysis only.
- Did not use a reliable and validated outcome measure of PTSD pre and post intervention.

Quality Criteria

The eligibility criteria allowed a mix of research designs to be included in this review e.g. randomized controlled trials, controlled trials, cohort and observational studies. When

considering a method for reviewing the quality of each study, a number of existing checklists and guidelines were consulted, including those from the Scottish Intercollegiate Guidelines Network (SIGN, 2014) and Cochrane (Cochrane, 2011). The majority of quality criteria checklists are developed specifically to evaluate one research design. A review of 60 quality assessment tools for evaluation of non-randomized studies and mixed study designs identified 6 tools suitable for systematic reviews (Deeks et al. 2003). One of these tools is the Downs and Black (1998) checklist, a tool specifically developed for the review of randomized and non-randomized studies. The checklist provides a profile of quality scores including 27 items distributed between 5 subscales- reporting (10 items), external validity (3 items), internal validity- bias (7 items), internal validity- confounding (6 items), and power (1 item). The checklist also provides a total score allowing for comparison and interpretation of studies according to methodological quality. All items are rated 1- yes (criteria met), 0- no (criteria not met), 0- unable to determine, except for the rating of confounding factors (item 5), which is rated 2- yes (criteria fully met), 1- (criteria partially met), 0-no (criteria not met). The only change made to the tool was with regard to question 27; instead of rating power on a 5 point Likert scale, the study was either rated 1- yes power was sufficient ($1-\beta=0.8$), 0- no study was underpowered. Therefore the total score possible to achieve with this tool is 28. The total score, termed the quality index score, has been shown to have high internal consistency, good inter-rater and test-retest reliability and good face and criterion validity (Downs & Black, 1998). For the purpose of this review the quality index scores were classified so that a score of $\geq 70\%$ was classed as 'good' quality, $\geq 50\%$ was classed as 'fair' quality and $< 50\%$ was classed as 'poor' quality.

Results

The database search identified a total of 707 studies. A hand search was also conducted by searching the reference lists of relevant theoretical reviews and chapters published in the area and the journals, *Mindfulness* and *The Journal of Clinical Psychology*. An additional 3 studies were identified through the hand searching process. After duplicates were removed there were 497 studies remaining, the titles of which were reviewed and 427 studies were excluded for not being relevant. The abstracts of the remaining 70 studies were then reviewed and a further 43 studies were excluded for not meeting eligibility criteria. At this stage reasons for exclusion included: the study being theoretical rather than empirical, no reliable, validated measure of PTSD being used, qualitative studies, and studies which used combined interventions e.g. mindfulness and EMDR, or interventions which included only one aspect of mindfulness e.g. loving kindness meditation. There were 2 studies which were conference abstracts only and upon further investigation were not published in full text; these studies were excluded as there was not enough information available regarding the methodology and results (Bremner et al., 2011; Dempsey et al., 2014). This left 25 studies which were subject to full text review. At this stage a further hand search was carried out of the reference lists of all 25 studies, this did not result in any unique studies being identified. 11 studies were excluded as they did not meet the inclusion/exclusion criteria (see Table 1). Therefore 14 studies met the full eligibility criteria for inclusion in the review, 2 of which were longitudinal follow up studies of original projects which were already included in the review (Branstrom, Kvillemo & Moskowitz, 2012; Earley et al., 2014); as such these studies were considered together- resulting in 12 unique studies (see Table 2). At this stage authors who had published several studies or had published theoretical reviews in the area were contacted to enquire about any relevant unpublished research for inclusion in the review. 8 authors were contacted by email over October and November 2014 although this did

not add any further studies for inclusion. An overview of the search and selection procedure is provided in a flow chart based on the PRISMA statement (Mohar, Liberati, Tetzlaff & Altma, 2009) (Figure 1).

Each study was reviewed according to the Downs and Black (1998) Quality Criteria Checklist by the first author (KB). A second rater (JS) who is a qualified Consultant Clinical Psychologist was asked to rate three papers, selected to represent different degrees of quality, to measure inter-rater reliability. The studies were fully anonymised so that the second rater was blind to the publication authors and journal to reduce any potential bias. Cohen's kappa (κ) indicated a substantial level of agreement between the raters- $\kappa= 0.79$ (Landis & Koch, 1977). The profile of quality review scores are outlined in Table 3.

Summary of Study Characteristics

The 12 studies included in this review featured 4 randomised controlled trials (Branstrom et al., 2010; Kearney et al., 2013; Kim et al., 2013; Niles et al., 2012), 1 controlled trial that was non-randomised (King et al., 2013) 3 uncontrolled trials (Kearney et al., 2012; Kimbrough et al., 2010; Smith 2010) and 4 pilot studies (Bhatnager et al., 2013; Centeno, 2013; Cox et al., 2014; Goldsmith et al., 2014). All the studies in this review used adult samples and employed reliable and valid outcome measures of mindfulness and PTSD. The main intervention approach used was MBSR; of the 9 studies which used this approach, 7 used the manualised program of 8 group sessions (Bhatnager et al., 2013; Branstrom et al., 2010; Goldsmith et al., 2014; Kearney et al., 2012; Kearney et al., 2013; Kimbrough et al., 2010; Smith, 2010) and 2 studies adapted MBSR into a tele-health intervention (Cox et al., 2014; Niles et al., 2012). There was only 1 study which used MBCT (King et al., 2013). The remaining 2 studies used other variations of mindfulness based interventions (Kim et al., 2013; Centeno, 2013).

It is worth noting the studies included in this review were largely heterogeneous in terms of the samples used. Particularly there was variation in the types of trauma studied- 2 studies investigated interpersonal trauma (Centeno, 2013; Smith, 2010), 1 study childhood sexual abuse (Kimbrough et al., 2010), 5 studies combat trauma (Bhatnager et al., 2013; Niles et al., 2012; Kearney et al., 2012, Kearney et al., 2013; Kim et al., 2013), 2 studies health related trauma (Branstrom et al., 2010; Cox et al., 2014) and 1 study used a sample of mixed trauma type (Goldsmith et al., 2013). The studies also varied in terms of PTSD diagnosis: 6 studies used samples in which 100% of participants were diagnosed with PTSD, or met criteria for PTSD diagnosis (Bhatnager et al., 2013; Centeno 2013; Niles et al., 2012; Kearney et al., 2013; King et al., 2013; Smith, 2010). 5 studies used samples in which all participants had been exposed to traumatic life events as defined by- direct exposure, witnessing or learning of an event that involves actual or threatened death or serious injury or harm to self or others (APA, 2013). These studies included childhood sexual abuse (Kimbrough et al., 2010), mixed traumatic life events as identified by the Life Events Checklist (Goldsmith et al., 2014), combat/ war zone (Kearney et al., 2012), and cancer or critical illness (Branstrom et al., 2010; Cox et al., 2014). 1 study used a healthy population, although 79% of them presented with PTSD symptoms (Kim et al., 2013).

Intervention Results

The methodological quality of the studies included was widely varied. Due to the limited research in the area pilot studies were included in the review although statistically significant findings cannot be drawn from these studies. Therefore the results will be discussed separately for each type of research design.

Pilot Studies

The search process identified 4 studies which were pilot studies with small sample sizes. Each study will be discussed in turn. Bhatnager et al. (2013) studied MBSR delivered in a group format. There was no report of treatment fidelity, or compliance. Out of the 8 participants, 5 showed a reduction in PTSD symptoms as measured by the Clinician Administered PTSD Scale (CAPS) at post intervention and 6 showed a reduction in CAPS score at one month post intervention. Goldsmith et al. (2014) also investigated MBSR delivered in a group format. Treatment fidelity was not reported, although compliance was measured through mean minutes of mindfulness practice per week, the mean increased over the treatment and indicated good treatment compliance. At post intervention mean scores showed a reduction in symptoms of PTSD, depression, shame based trauma appraisals and increased acceptance of emotional experience. Cox et al. (2014) investigated the use of MBSR delivered through a tele-health intervention. There was no report of treatment fidelity or compliance. The study reported that 6 of the 8 participants showed a reduction in PTSD symptoms, anxiety and depression at post intervention. The Client Satisfaction Questionnaire showed that participants were highly satisfied with the intervention. Centeno (2013) investigated a mindfulness meditation training group intervention delivered by a trained, experienced facilitator. The study measured minutes spent on mindfulness practice per week and this indicated good treatment compliance. The study reported an increase in mindfulness and a decrease in PTSD symptoms post intervention. However the sample was also engaged in ongoing concurrent psychotherapy. All pilot studies reported positive improvements in PTSD symptoms, although due to the small samples used we cannot determine if this represents statistically significant change.

Non-controlled Trials

Three of the studies identified were non-controlled trials. Smith (2010) investigated MBSR delivered in a group format. The treatment was audio recorded and rated for fidelity, and participants reported an average 3.3 hours practice per week, indicating good compliance. The study reported that post intervention there was a significant reduction in PTSD symptoms, whilst mindfulness, self-compassion and sense of coherence increased, all with large effect sizes. However the sample had ongoing concurrent psychotherapy throughout the intervention. Kimbrough et al. (2010) also investigated MBSR delivered in a group format. The intervention was delivered by a trained interventionist, and participants reported a mean of 44 minutes mindfulness practice per day indicating good compliance. This study reported significant improvements in anxiety, depression, mindfulness and PTSD symptoms, particularly avoidance, with large effect sizes at post intervention. However this study sample also had ongoing concurrent psychotherapy. Kearney et al. (2012) also investigated MBSR delivered in a group format. The intervention was delivered by a trained interventionist, although compliance with mindfulness practice was not reported. The study reports significant improvements with PTSD, depression, mindfulness and acceptance, with medium effect sizes. However, again the sample had ongoing concurrent psychiatric and psychological input throughout. All 3 non-controlled trials indicated positive findings, although all 3 included samples with ongoing psychotherapy which may have contaminated results. Furthermore the absence of control group in these studies means it's difficult to attribute any change purely to the mindfulness intervention.

Controlled Trials

There was 1 non-randomised controlled trial identified in the search process. King et al. (2013) compared three treatment arms- MBSR delivered in a group format, treatment as usual and a psycho-education group. Although they used an active comparison group, the psycho-

education group did not match the MBSR group in terms of contact hours or homework. The MBSR intervention was delivered by a trained facilitator and audio recordings, supervision and a treatment checklist was used to ensure treatment fidelity. The study reports good compliance with homework exercises. Post intervention the study found that the MBCT group showed significant improvement in PTSD symptoms and a significant reduction in negative cognitions including self-blame compared to the other groups with medium effect sizes. However it is worth noting that improvements in PTSD symptoms seem to have been largely due to a change in symptoms of avoidance and numbing, rather than symptoms of intrusive thoughts or hyper-arousal.

Randomised Controlled Trials

There were 4 randomised controlled trials found through the search process. Branstrom et al. (2010) compared group delivered MBSR to a waitlist control group. Treatment fidelity is not reported; although during the intervention 88% of participants were practising meditation out with the group at least once a week or more, indicating good compliance. At post intervention the study found that the MBSR group showed significant decreases in perceived stress, post-traumatic avoidance and significant increases in positive states of mind, all with medium effect sizes. There were no significant differences in the groups for depression or anxiety. Kearney et al. (2013) also investigated MBSR delivered in a group format compared to treatment as usual. The interventionists were appropriately trained, although compliance with mindfulness practice was not reported. The study found that there were no significant differences at post intervention between the MBSR and treatment as usual groups in PTSD symptoms; however the MBSR group did show significant improvement in Health Related Quality of Life (HR-QOL). Niles et al. (2012) compared a MBSR tele-health intervention to a psycho-education tele-health

intervention. The use of an active control group reduced the chance of effects being placebo alone, although the sample had ongoing concurrent psychotherapy. The interventionist used a checklist to ensure treatment fidelity, and compliance with intervention homework was good, with 89% of the sample completing at least 75% of the homework. At post intervention there was a significant decrease in PTSD symptoms in the MBSR group compared to the psycho-education group with large effect sizes. Kim et al. (2013) developed a group program of mindful breathing and stretching over 16 1 hr bi-weekly sessions and compared this intervention to waitlist controls and a healthy sample. They found that post intervention PTSD symptoms significantly improved in the mindfulness group compared to controls with large effect sizes in all three symptom subscales of re-experiencing, hyper arousal and avoidance. Out of the 4 RCTs, 3 reported improvements in PTSD symptoms; the one which found no significant change was the only one to include a chronic PTSD sample (Kearney et al., 2013).

Sustainability of Results

There were 7 studies which included a longitudinal long term follow up, 2 of which indicated that effects were not sustained at follow up. Niles et al. (2012) found significant improvements in PTSD symptoms post intervention, although found these changes were not sustained at the 6 week follow up; it is worth noting this study used a tele-health intervention, which was a relatively brief intervention compared to the others. Similarly however Branstrom et al. (2012) used a more intensive manualised 8 week group model of MBSR and also found that significant changes post-intervention in symptoms of PTSD were not sustained at 6 month follow up. These results contrast with the other 5 studies which had a longitudinal follow up. The Kearney et al. (2013) study failed to find improvements in PTSD at post intervention compared to controls; however at 4 month follow up the MBSR group showed more clinically meaningful change in

PTSD than the control group. A further 4 studies found that improvements in PTSD symptoms were largely sustained at 4 months (King et al., 2013) 6 months (Kearney et al., 2013) 7 months (Kimbrough et al., 2010) and 30 months follow up (Earley et al., 2014).

Attrition Rates

The majority of studies reported completion rates for the intervention; only 3 studies did not report completion rates (Bhatnager et al., 2013; Centeno, 2013; Goldsmith et al., 2014). There was variation in how ‘treatment completers’ were defined. Where completion was defined by attendance at 4 or more sessions then the rate of non-completers varied from 11-26% (Branstrom et al., 2010; Kearney et al., 2012; Kearney et al., 2013; Kimbrough et al., 2010). Where completion was defined by attendance at 5 or more sessions, the rate of non-completers ranged from 25-49% (King et al., 2013; Smith 2010). Only one study defined completion as attendance of 100% of sessions, they reported a non-completion rate of 36% (Cox et al., 2014). Kim et al. (2013) defined completion as attending 75% of the 16 sessions; they reported a 4% non-completion rate. Niles et al. (2013) reported a 24% non-completion rate, but did not define what classed as ‘completion’.

Adverse Effects

There were 4 studies that explicitly stated there were no adverse effects as a result of the treatment (Branstrom et al., 2010; Niles et al., 2012; Kearney et al., 2012; Kimbrough et al. 2010), 2 studies did not report on adverse effects (Kim et al., 2013; Smith, 2010). The remaining 6 studies that reported adverse effects reported that increases in symptoms were not clinically significant. Bhatnager et al. (2013) reported that 1 participant showed a 2 point increase on the CAPS, a rise of >10 points being considered clinically meaningful. Goldsmith et al. (2014) found that 2 participants had a rise in PTSD symptoms and 1 participant had a rise in depression,

however these changes were not defined as reliable by the reliable change index. From qualitative feedback from the interventions, Centeno (2013) found that 2 patients reported anxiety during meditation and King et al. (2013) found that 2 patients reported increased anxiety during exercises regarding bodily states, with 1 reporting this exercise triggered memories of assault. In both these studies the participants continued with the intervention. Cox et al. (2014) did not use a sample with diagnosed PTSD, rather they used a sample of critical illness survivors, and reported 3 participants had unchanged or worsened PTSS and HADS scores. Finally Kearney et al. (2013) found that 1 patient from the MBSR group and 1 from the treatment as usual group experienced an inpatient admission during the study; however they report that this did not seem to be a direct result of MBSR.

Discussion

This review suggests that further research investigating mindfulness based approaches for treating symptoms of PTSD in adults may be useful. The majority of studies reported improvements in PTSD symptoms at post intervention, and improvements were largely sustained in studies which featured a long term follow up ranging from 4-30 months. From the studies that reported individual subscales of PTSD symptoms, there was agreement between 4 studies that avoidance symptoms showed the most improvement, with large effect sizes (Branstrom et al., 2010; Kimbrough et al., 2010, King et al., 2013; Smith, 2010). The majority of studies reported significant improvements in mindfulness and acceptance. The studies reviewed indicate that there are minimal adverse effects of mindfulness interventions. It is evident from this review that the results are encouraging; therefore further research would be useful to advance our understanding of the effectiveness of mindfulness based interventions for PTSD symptoms.

However it is important that the results of this review are interpreted with caution, as the majority of studies included in this review were of low to moderate methodological rigour. Due to a lack of research in the field this review included a small number of studies and pilot studies with small samples. Only four studies included a control group with a randomised design, which is considered the gold standard for intervention research. Out of the 5 studies that used a control group, only 2 studies used an active control (Niles et al., 2012; King et al., 2013). Nearly half of the studies used samples that had ongoing psychotherapy input which may have contaminated the results of the mindfulness intervention (Centeno, 2013; Niles et al., 2012; Kearney et al., 2012; Kimbrough, 2010; Smith 2010). Due to these methodological limitations it is not possible to draw a conclusive statement about the effectiveness of mindfulness interventions for treating PTSD symptoms at this time.

All studies in this review were published within the last four years, suggesting this is an area of rapidly increasing research attention. It is however important to note that these results may reflect publication bias in which studies with positive results are more likely to be published and disseminated than those with negative outcomes (Easterbrook, Gopalan, Berlin & Matthews, 1991). An attempt was made to reduce this bias by contacting authors for unpublished studies, although this attempt did not uncover any unpublished work in the field, and does not account for work by authors who were not contacted. Future studies in this field would benefit from larger samples, adequate power and RCT designs with an appropriately matched control group. To effectively evaluate the intervention future studies should be conducted without ongoing psychotherapy to avoid contamination of the intervention results. To increase internal validity future studies would also benefit from using adequate blinding procedures for researchers and participants. When considering the mindfulness interventions provided in future trials, it may be

useful to modify mindfulness interventions for PTSD, particularly in terms of being sensitive to body focused interventions for certain trauma types (King et al., 2013). Future trials should use adequately trained therapists experienced in monitoring any indications of increased anxiety.

Strengths

This is the first review of its kind which specifically focuses on the utility of mindfulness based approaches on symptoms of PTSD. The findings of this review are therefore an important first step in interpreting the existing research base, and informing future studies. The majority of studies included in this review used interventions based on MBSR, so they shared a degree of commonality. The outcome measures used in the studies were all robust and well validated reliable measures allowing for more meaningful comparison. The inter-rater validity for the quality ratings within the review indicated a substantial level of agreement between the raters. From this preliminary investigation it seems that adverse effects of mindfulness are limited and effectiveness of treating PTSD is encouraging. Clinically there are already a significant number of professionals trained in approaches such as MBSR, and mindfulness approaches are already relatively well integrated into health care systems. Therefore application of this approach with this client group may be relatively practical to implement in terms of existing resources. Although approaches such as MBSR are time intensive with 2.5 hrs over 8 sessions, the group approach to delivery means it may still be less time intensive than providing individual therapy.

Limitations

There are several limitations to this review, predominantly in the heterogeneous nature of the samples included, which meant that a meta-synthesis of results was not feasible and instead a narrative summary has been utilised. Mainly the studies varied in terms of trauma populations and severity of PTSD symptoms/ diagnosis. Research has shown that exposure to different types

of traumatic event whether sexual abuse, transport accident, illness, physical abuse can result in varying post traumatic reactions, particularly in the experience of negative emotion (Amstadter & Vernon, 2008). Other factors such as time since the trauma and severity of trauma exposure, one off events vs. prolonged repeated trauma can also vastly affect the experience of PTSD symptoms (Cloitre et al., 2009). Despite this the results of this review do not suggest that there were any significant differences in the effectiveness of mindfulness interventions between groups in terms of trauma type.

As this is an initial review of the research, the review includes a small number of studies. Several studies included in this review were pilot studies with small samples; therefore it is not possible to draw any statistically significant findings from these studies. The remaining studies had methodological limitations which further reduces the strength of evidence that can be drawn from these studies. There was significant heterogeneity in the methodological quality of the studies included in this review, and therefore a collective synthesis of this evidence was not possible. Another limitation of this review is within the quality ratings of the studies included. It is important to note that although there was substantial inter-rater agreement about the quality of the studies, this was based on a relatively small sample as only 3 papers out of the full 12 were subject to inter-rater review.

There has been a wealth of research which has focused on qualitative analysis of mindfulness based interventions with PTSD populations (e.g. Dutton et al., 2011); it was out-with the scope of this current review to evaluate these findings. However qualitative reports add a unique and valuable contribution to determining the effectiveness of these interventions. Two studies included in this review used a mixed methods design in which quantitative findings were substantiated with qualitative analysis (Centeno, 2013; Smith, 2010). It would be useful for

future reviews to evaluate qualitative studies in this area. The majority of research studies included in this review were conducted within North America or Europe which suggests a level of cultural bias. These results therefore may not translate into non-Western and non-English speaking populations.

Conclusions

This review aimed to synthesise and evaluate the existing research on the use of mindfulness based approaches for symptoms of PTSD in adults. Preliminary results suggest mindfulness based interventions may be useful to decrease PTSD symptoms particularly in terms of avoidance. The review shows that research in this area is limited and as such there was a small number of the studies included in this review and many were of limited methodological quality. The studies included within the review are also relatively heterogeneous in terms of samples with exposure to different trauma types and with varying degrees of PTSD severity. The heterogeneity and poor methodological quality of studies included means that results should be interpreted with caution. This preliminary review suggests that it may be beneficial to research mindfulness based interventions further with PTSD symptoms. This review highlights important considerations for future research methodologically in terms of the need to use control groups with adequately randomised samples and appropriate use of blinding to minimise bias. There is also the need for future studies to include larger samples without ongoing psychotherapy to ensure adequate power and reliability of results.

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Figure 1. PRISMA Flow Chart.

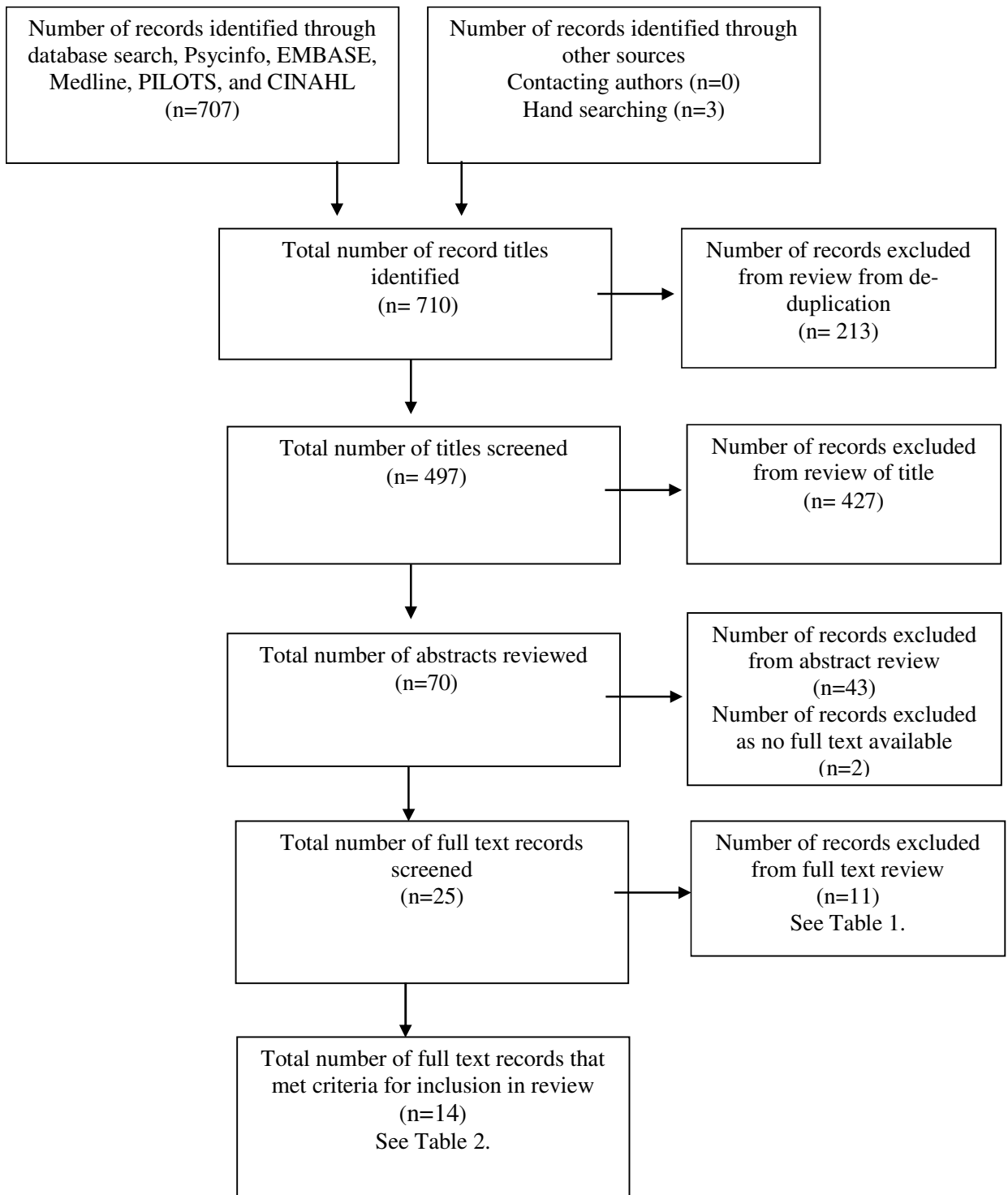


Table 1. Articles Excluded from Full-text Review

Study	Reason for Exclusion
Blankenship (2014)	No pre-post measure of PTSD
Bittleman & Ruberg (2014)	PTSD case study- no formal quantitative PTSD outcome measure used
Boden et al. (2012)	CBT intervention- not mindfulness based
Dutton, Bermudez, Matas, Majid & Myers (2013)	Qualitative study only
Khong (2011)	PTSD case study- no formal quantitative measures of PTSD used
Omidi, Mohammadi, Zargar & Akbari (2013)	No pre-post measure of PTSD
Owens, Walter, Chard & Davis (2012)	Mindfulness combined with CBT and PE treatment program
Pigeon, Allen, Possemato, Bergen-Cico & Treatman (2014)	No formal quantitative PTSD outcome measure used
Price, Wells, Donovan & Rue (2007)	Qualitative study only
Reber et al. (2013)	CBT intervention- not mindfulness based
Wahbeh (2014)	No formal quantitative PTSD outcome measure used

Table 2. Articles Included in the Review

Study	Participants	Intervention	Outcome Measures	Design/ follow up	Attrition/ Completion Rates	Adverse Effects	Results/ Effect sizes (Cohen's d)
Bhatnagar et al. (2013)	8 combat veterans, (7 male) mean age 59.5 years (range 42-71 years) All with PTSD diagnosis	Mindfulness based stress reduction (MBSR) group	CAPS/ heart rate variability	No control group Pre-post-1mth follow-up	Not reported	1 patient showed an increase in CAPS score by 2 points between baseline and 1 month follow up- this change was not considered clinically significant	1 month post intervention PTSD symptoms decreased as measured by the CAPS score.
Branstrom, Kvillemo, Brandberg & Moskowitz (2010)	71 patients treated for cancer, (70 women) mean age 51.8 years (range 30-65 years) Mean score of IES-R for the sample indicated a medium level of PTSD distress	Mindfulness based stress reduction (MBSR) group 8 weekly 2hr sessions (ongoing psychiatry involvement- 32.4% on anti-depressants)	PSS/ HADS/ IES-R/ PSOM/ FFMQ	RCT-2 arms MBSR/ waitlist control Pre- post- 3mth follow up	Completion defined by attending 4 or more sessions-. 84.3% attended 4 or more sessions, 15.6% attended less than 4 sessions	Study reports that there were no adverse side effects as a result of treatment	At post intervention the MSBR group showed a larger decrease than controls in psychological symptoms- perceived stress (d=0.63), posttraumatic avoidance (d=0.41), and increased positive states of mind (d=0.50). Results were not significant for depression or anxiety.
Branstrom, Kvillemo & Moskowitz (2012)	37 patients returned for 6mth follow up from Branstrom	Mindfulness based stress reduction (MBSR) group	PSS/ HADS/ IES-R/ PSOM/ CSES/ FFMQ	6mth follow up	(see above)	Study reports that there were no adverse side effects as a result of treatment	The MBSR group sustained the increase in mindfulness at 6mth follow up

	et al. (2010) study						compared to controls. There were no other differences in the groups.
Centeno (2013).	10 survivors of intimate partner violence (10 female). Aged 28-58 years All with PTSD diagnosis.	Mindful meditation training classes, 6weeks (ongoing concurrent psychotherapy for 3 participants)	Qualitative Interviews/ PSS/ PCL-10/ FMI	No control group Mixed study design- qualitative/ quantitative Pre-post measures, no long term follow up	Not reported	2 patients reported increased anxiety during meditation however did not drop out. there were no increases in quantitative measures of symptoms from pre-post therapy	At post intervention there was a decrease in PTSD symptoms and increase in mindfulness skills
Cox et al. (2014)	11 survivors of critical illness, (8 female) mean age 54 years (range 27-59 years)	Telephone delivered mindfulness intervention- 6 weekly sessions	HADS/ PTSS/ FFMQ/ ERQ/ CSQ/ APACHE II	No control group Pre-post measures, no long term follow up	Completion defined as attending all 6 sessions- 64% completion rate	3 participants had worsened or unchanged HADS and PTSS scores, all 3 experienced significant life stressors/ worsening health	At post intervention 63% of the sample showed improved PTSS scores. Pre-post intervention PTSS scores were correlated with mindfulness scores on the FFMQ
Goldsmith et al. (2014)	10 participants with mixed trauma exposure (9 female/ 4 Caucasian) 6 with probable PTSD diagnosis/ 7 screened	Mindfulness based stress reduction (MBSR) group manualised program	PHQ/ BDI/ PCL/ AAQ-II/ CTQ/ LEC/ TAQ	No control group Pre-post measures- no long term follow up	Not reported	Increases in symptoms of PTSD (2 participants) and depression (1 participant) were not reliable as defined by the reliable change index	At post intervention there was a reduction in symptoms of PTSD, depression and shame based trauma appraisals. There was an increase in acceptance of

	positive for child abuse						emotional experience
Niles et al. (2012)	33 male combat veterans- mean age 52 years (range 23-66) All met PTSD criteria	Tele-health based on MBSR 2x 45 min in-person sessions/ 6x 20min weekly phone calls Ongoing concurrent psychiatry and psychotherapy treatment)	CAPS/ PCL-M/ PSQ	RCT- 2 treatment arms- tele-health MBSR/ tele-health psycho-education Pre-post-6wk follow up	76% classed as completing MBCT treatment	Study reports that there were no adverse reactions to treatment	At post intervention the mindfulness group showed a significant decrease in PTSD symptoms (d=0.84) and decrease in CAPS score (d=0.70). At 6 week follow up changes in PTSD in the mindfulness group were not sustained (d=0.16) Between group effect sizes post intervention were PTSD (d=1.95) CAPS (d=1.27)
Kearney, McDermott, Malte, Martinez & Simpson (2012)	92 veterans (70 male, 76 Caucasian) 74% screened positive for PTSD at baseline	Mindfulness based stress reduction (MBSR) group 8x 2.5 hr weekly sessions + 1x 7hr day session (adjunct to usual psychiatric and psychological care)	PCL-C/ PHQ-9/ BADS/ SF8/ AAQ/ FFMQ	No control group Pre-post measures- 4months follow up	Completion defined as attending 4 or more classes- 74% of participants completed MBSR	The study reported that there were no adverse effects- no participants withdrew due to worsening symptoms	At post intervention- there were significant improvements in PTSD symptoms (d=0.55) Depression (d=0.53) Mindfulness (d=0.69) and Acceptance (d=0.65) PTSD subscales-

							<p>Re-experiencing (d=0.40) Avoidance (d=0.36) Hyper arousal (d=0.64) Numbing (d=0.46)</p> <p>At 6mth follow up improvements were sustained- PTSD (d=0.64) Depression (d=0.70) Mindfulness (d=0.78) Acceptance (d=0.68)</p>
<p>Kearney, McDermott, Malte & Martinez (2013).</p>	<p>47 veterans (37 male/ 32 Caucasian)</p> <p>All with diagnosis of chronic PTSD</p>	<p>Mindfulness based stress reduction (MBSR) group 8x 2.5 hr weekly sessions + 1x 7 hr day session</p>	<p>PCL-C/ LEC/ PHQ-9/ HRQOL/ FFMQ/ BADS</p>	<p>RCT- 2 treatment arms MBSR/ treatment as usual</p> <p>Pre-post measures- 4mth follow up</p>	<p>Completion defined as attending 4 or more classes- 84% of MBSR group completed.</p>	<p>1 patient in each treatment arm experienced inpatient psychiatry admission due to increased PTSD symptoms/ no one withdrew from MBSR due to increased symptoms</p>	<p>At post intervention the MBSR and TAU group showed no significant differences in PTSD, depression, or behaviour activation.</p> <p>Post intervention there was improvement in mindfulness scores in the MBSR group (d=0.65)</p> <p>At 4mth follow up improvement in mindfulness was sustained (d=0.67)</p>

<p>Kim et al. (2013)</p>	<p>29 nurses (28 female) Aged 45-66 years 79% with PTSD symptoms</p>	<p>Mindfulness based stretching and deep breathing (MBX) group 16x 1hr biweekly sessions over 8 wks</p>	<p>PCL-C/ serum cortisol/ plasma ACTH/ serum DHEAS</p>	<p>RCT- 3 treatment arms- MBX/ control- no treatment/ baseline- healthy sample Pre-mid- post measures- no long term follow up</p>	<p>Completion defined by attending 75 % of the sessions- 28 participants (96%) completed</p>	<p>Study doesn't report on adverse effects</p>	<p>At post intervention the MBX group showed significant improvement in total PTSD symptoms (d=2.28) re-experiencing (d=2.04) avoidance (d=1.82) and hyper arousal (d=1.72). Improvements in PTSD were significant compared to controls (d=1.42). At 16 weeks improvements were sustained.</p>
<p>Kimbrough, Magyari, Langenberg, Chesney & Berman (2010)</p>	<p>27 adult survivors of childhood sexual abuse (24 female/ 21 Caucasian) Mean age 45 years (range23- 68) 15 met criteria for PTSD</p>	<p>Mindfulness Based Stress Reduction (MBSR) 8x 2.5 hr weekly classes + 1x 5hr day session (all in concurrent psychotherapy)</p>	<p>BDI/ PCL/ BSI/ MAAS</p>	<p>No control group Pre- mid- post measures, 24 wk post baseline follow up</p>	<p>Intervention retention rates- 4 wk- 89% 8wk- 85% 24 wk- 78%</p>	<p>No adverse events at the moderate or higher level reported at any time during the study</p>	<p>At post intervention there were significant improvements in, PTSD (d=1.20), Anxiety (d=1.10) Depression (d=1.75) Mindfulness (d=1.20). PTSD subscales- avoidance/ numbing (d=1.43), hyper arousal (d= 1.29) and re- experiencing (d=0.66)</p>

							Improvements from baseline were largely sustained at 24 week follow up- PTSD (d=0.79) Anxiety (d=0.90) Depression (d=0.96) Mindfulness (d=1.0)
Earley et al., (2014).	19 returned for 2.5 year follow up from Kimbrough et al. (2010) study	Mindfulness based stress reduction (MBSR) group	BDI/ PCL/BSI-anxiety subscale/ MAAS	Longitudinal, 2.5 year follow up	N/A	No adverse effects reported	At 2.5 year follow up improvements in PTSD symptoms, depression/ anxiety and mindfulness skills were mainly sustained PTSD (d=0.78) Anxiety (d=0.9) Depression (d=1.07) Mindfulness (d=1.1)
King et al. (2013)	37 veterans MBCT group- 20 participants (mean age 60.1 years) TAU group- 17 participants (mean age 58.3 years) All with long term PTSD (ongoing for at least 10 years or more)	Mindfulness Based Cognitive Therapy (MBCT) group 8 weekly sessions	CAPS/ PDS/ PTCI	Controlled trial, not randomised 3 treatment arms- MBCT/ treatment as usual/ comparison group- psycho-education Pre-post therapy, no long term follow up	Completion defined as attending 5 or more sessions 15 out of 20 participants completed the MBCT treatment (25% drop out rate)	2 participants reported increased anxiety during mindfulness exercises involving bodily states. 1 participant reported 'body scan' triggered memories of assault	At post intervention the MBCT group showed significant improvement in CAPS total (d=0.56) and PTSD symptoms- intrusive thoughts (d=0.20) avoidance (d=0.77) hyper-arousal (d=0.24). The MBCT group CAPS scores improved

							<p>significantly more than the TAU group between pre-post intervention (d=0.8).</p> <p>Completer analysis also showed improvement in PTCI- negative self (d=0.43) negative world (d=0.59) and self-blame (d=1.0)</p>
Smith (2010)	<p>29 women with histories of physical/ psychological interpersonal abuse</p> <p>Mean age 46.7 years (range 25-82 years)</p> <p>All with probable PTSD</p>	<p>Mindfulness Based Stress Reduction (MBSR) group -8 weekly sessions</p> <p>(ongoing concurrent psychotherapy/ psychiatry)</p>	<p>PCL-C/ DAPS/ MAAS/ SCL-90-R/ CR-PTSD/ SOC-29 SCS/ blood pressure & heart rate/ Qualitative interview</p>	<p>No control group</p> <p>Mixed methods exploration- qualitative/ quantitative design</p> <p>Pre-post measures, no long term follow up</p>	<p>Completion defined by attending 5 or more sessions- 15 out of 29 completed the MBSR course, 49% non-completion rate</p>	<p>Study does not report on adverse effects</p>	<p>At post intervention there were decreases in total PTSD symptom scores (d=1.54), re-experiencing (d=1.28) avoidance (d=0.93) and arousal (d=0.77).</p> <p>There were increases in mindfulness (d=.82), sense of coherence (d=1.46) and self-compassion (d=1.35).</p>

Outcome measures: Clinician Administered Posttraumatic Stress Scale (CAPS)/ Perceived Stress Scale (PSS)/ Hospital Anxiety and Depression Scale (HADS)/ Impact of Events Scale- Revised (IES-R)/ Positive States of Mind (PSOM)/ Coping Self-Efficacy Scale (CSES)/ Posttraumatic Symptoms Scale (PTSS)/ Emotion Regulation Questionnaire (ERQ)/ Life Events Checklist (LEC)/ Dissociative Experiences Scale (DES)/ Basic Symptoms Inventory (BSI)/ Positive and Negative Affect Scale (PANAS)/ Anxiety Sensitivity Index (ASI)/ Freiberg Mindfulness Inventory (FMI)/ Five Facet Mindfulness (FFMQ)/ Toronto

Mindfulness Scale (TMS)/ PTSD Symptom Checklist- Civilian (PCL-C)/ Beck Depression Inventory (BDI)/ Acceptance and Action Questionnaire (AAQ-II)/ Acute Physiology and Chronic Health Evaluation (APACHE-II)/ Kentucky Inventory of Mindfulness (KIMS)/ Patient Health Questionnaire (PHQ)/ Short Form-8 (SF8)/ Health Related Quality of Life (HRQOL)/ Behaviour Activation for Depression Scale (BADSD)/ Detailed Assessment of Post-Traumatic Stress (DAPS)/ Crime Related PTSD (CR-PTSD)/ Self-compassion Scale (SCS)/ Orientation to Life Questionnaire (SOC-29)/ Symptoms Checklist (SCL-90)/ The Post Traumatic Stress Diagnostic Scale (PDS)/ Posttraumatic Cognitions Inventory (PCTI)/ Mindful Attention Awareness Scale (MAAS)/ Child Trauma Questionnaire (CTQ)/ Trauma Appraisal Questionnaire (TAQ)