



MINDFULNESS TRAINING FOR HEALTH PROFESSION STUDENTS—THE EFFECT OF MINDFULNESS TRAINING ON PSYCHOLOGICAL WELL-BEING, LEARNING AND CLINICAL PERFORMANCE OF HEALTH PROFESSIONAL STUDENTS: A SYSTEMATIC REVIEW OF RANDOMIZED AND NON-RANDOMIZED CONTROLLED TRIALS

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Background: High levels of stress have been identified in medical students and increasingly in other health profession student population groups. As stress can affect psychological well-being and interfere with learning and clinical performance, there is a clear argument for universities to include health professional student well-being as an outcome in core curriculum. Mindfulness training is a potential construct to manage stress and enhance academic success.

Objectives: The aims of this systematic review were to assess the effectiveness of mindfulness training in medical and other health professional student population groups and to compare the effectiveness of the different mindfulness-based programs.

Data Sources: A literature search was completed using The Cochrane library, Medline, Cinahl, Embase, Psychinfo, and ERIC (proquest) electronic databases from inception to June 2016. Randomized and non-randomized controlled trials were included. Of the potential 5355 articles, 19 met the inclusion criteria.

Study Selection Participants and Interventions: Studies focused on medical ($n = 10$), nursing ($n = 4$), social work

($n = 1$), psychology ($n = 1$), and medical plus other health ($n = 3$) students. Interventions were based on mindfulness.

Data Extraction: The 19 studies included 1815 participants. Meta-analysis was performed evaluating the effect of mindfulness training on mindfulness, anxiety, depression, stress, mood, self-efficacy, and empathy. The effect of mindfulness on academic performance was discussed.

Data Synthesis and Conclusions: Mindfulness-based interventions decrease stress, anxiety, and depression and improve mindfulness, mood, self-efficacy, and empathy in health profession students. Due to the range of presentation options, mindfulness training can be relatively easily adapted and integrated into health professional training programs.

Keywords: health professional students, mindfulness, mindfulness-based stress reduction, stress, well-being, systematic review

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BACKGROUND

There is a large body of literature observing widespread levels of anxiety, depression, and stress in medical students compared to the general population.^{1,2} This is, in spite of no

evidence of higher anxiety at the commencement of the medical training.³

Although this literature is based on medical student populations, many of the stressors associated with university life and clinical placements common in medical training will be present in the training of all health professionals including dentists, nurses, psychologists, social workers, and physiotherapists. There is a growing number of studies observing decreased psychological well-being in students in these other professional programs.⁴

Psychological distress can affect academic⁵ and clinical placement performance.⁶ However, situations are not inherently stressful, it is the student's perception of stress

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and response to a challenging situation including regulation of their emotions, the development of effective coping strategies, and resilience, which determines the degree of stress experienced.⁷

Educators are turning to health promotion interventions to decrease stress and promote resilience in University students.^{8–10} These interventions can take many forms including a mindfulness approach. Mindfulness-based stress reduction (MBSR)¹¹ and mindfulness-based cognitive therapy¹² are two widely used mindfulness-based programs. Mindfulness is defined as “the awareness that emerges through paying attention on purpose, in the present moment, and nonjudgmentally to the unfolding experience moment by moment.”¹¹ Mindfulness includes formal meditation practice undertaken regularly and informal practice aimed at bringing attention and awareness into all aspects of life. The mindful experience occurring during mindful meditation can be described as state mindfulness. When this becomes more lasting and leads to a predisposition to be mindful in everyday life this can be conceptualized as trait mindfulness.¹³ Practicing state mindfulness may lead to improving trait mindfulness.¹⁴

Higher levels of mindfulness are associated with lower levels of depression, anxiety, and stress^{15,16} and can facilitate a range of well-being outcomes including lower stress perception,^{13,17} more adaptive coping strategy use,¹⁷ and an ability to see a situation more clearly and respond more effectively.¹⁸ In the clinical context, patients rated clinicians with higher mindfulness scores more highly on clinician communication and on overall satisfaction.¹⁹

Although mindfulness has been recognized as a useful tool to enhance the health and well-being of clients,²⁰ there is now an increasing interest in the use of mindfulness to improve student well-being, enhance academic performance, and prepare beginner health practitioners to be reflective, empathetic, and patient centered in their practice.

Two systematic reviews looking at stress management programs in medical education have been published. One systematic review included articles published prior to 1999.²¹ A more recent review looked at a range of stress management approaches, and the efficacy of these different approaches for decreasing stress. The review only included populations of medical students. The programs based on mindfulness and pass/fail grading decreased stress and anxiety measured by State and Trait Anxiety (STAI-1), Profile of Mood States (POMS), Symptom Checklist (SCL-90), Perceived Stress of Medical School (PSMS), Perceived Stress Scale (PSS), and Depression and Anxiety Stress Scale (DASS), although only one study of very high quality was found.¹⁰ Another review looked specifically at teaching mindfulness to medical and dental students and has provided a comprehensive summary of the different formats used for teaching mindfulness currently in medical schools. However, due to the lack of published literature the authors searched and used gray literature, primarily websites of medical schools that included mindfulness programs, to ascertain information about the various programs.²²

OBJECTIVE

The primary aim of this review is to identify randomized controlled and non-randomized controlled trials using only mindfulness-based interventions, to identify the effectiveness

of mindfulness alone in reducing stress, improving psychological well-being, enhancing student learning, and clinical performance. Whereas Shiralkar et al.¹⁰ and Dobkin and Hutchinson²² included only medical students, this review will be expanded to include all health professional students. The secondary aim is to describe the interventions and how they were integrated into teaching programs to explore which components of the programs seem to be most effective.

METHODS

The review was prepared using the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines.

The Cochrane Library, Medline, Cinahl, Embase, Psycinfo, and ERIC (proquest) electronic databases were searched from inception until June 2016. Reference lists of systematic reviews and included articles were manually scanned to ensure no key articles had been missed in the initial search. Google scholar was used to track citations of all included articles. Hand searching mindfulness research monthly www.mindfulexperience.org was performed to identify recent publications. Only articles published in peer review journals were included. All references were imported into Endnote version X6 (Thomas Reuters, New York, NY), duplicates and non-English articles were deleted by one reviewer J.McC. The search strategy was based on the PICO model (population, intervention, comparison, and outcome) (Table 1).

See Appendix 1 for an example of the search strategy as applied in Medline.

Eligibility Criteria

Population. Undergraduate or post-graduate students studying in a health professional course, including medicine, psychology, social work, nursing, occupational therapy, podiatry, dietetics, and physical therapy. Population groups with a medical diagnosis were excluded, as this review is interested in the effectiveness of mindfulness in a normal student population.

Intervention. Mindfulness programs with the intention of improving mindfulness, self-care, engagement in academic learning, empathy, or reflective practice were included. Specifically programs based on mindful meditation, loving kindness meditation, mindful movement, Zen, Vipassna, mindfulness-based stress reduction,¹¹ and mindfulness-based cognitive therapy.¹² Transcendental meditation and relaxation response were not included as they are concentrative rather than mindfulness-based meditations. Trials training health professionals in the use of mindfulness as a clinical treatment tool were not included as this review is focused on using mindfulness to enhance the health professional students' learning, quality of being and by extension their ability to manage stress and relate to patients.

Outcomes. The outcomes of interest were quantitative to allow statistical analysis. Outcomes included measures of mindfulness, depression, anxiety, stress, wellness, study

Table 1. Search Strategy

Population	Intervention	Comparison	Outcome
Student health professional	Mindfulness, meditation, mindfulness-based stress reduction, mindfulness-based cognitive therapy, embodied mindfulness, and Zen and Vipassna	Control or other intervention	Mindfulness, stress, anxiety, depression, self-care, self-compassion, coping strategies, psychological well-being, study, cognition, attention, engagement, interpersonal sensitivity, empathy, and reflective practice

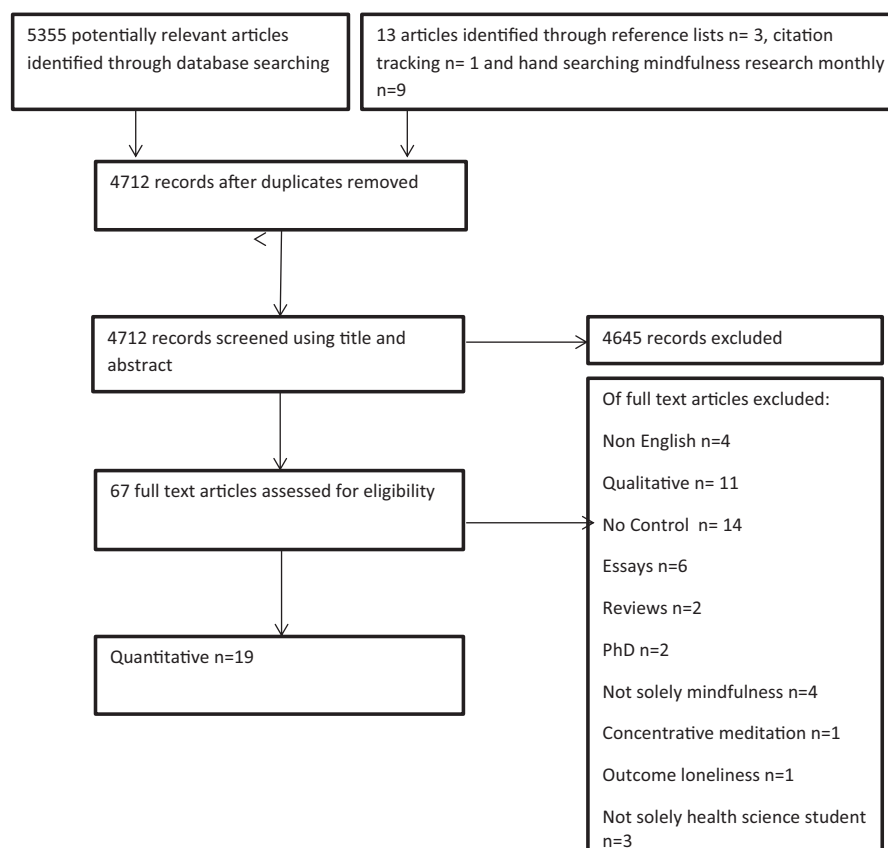
engagement, empathy, self-compassion, self-regulation, self-efficacy, reflective practice, and academic achievement.

The nature, frequency, length, and content of the interventions and whether they were part of the core curriculum or an elective were recorded.

Types of trials. Randomized controlled trials and parallel prospective cohort trials (where the comparison and intervention groups were assessed at the same time) were included. Non-randomized trials were included due to the low anticipated number of randomized controlled trials. A parallel control group was required to control for specific stresses at

the time of data collection which will vary at different times in the academic year. Articles written in a language other than English were not included because it was not possible to translate the articles. Case studies, opinion pieces, and non-systematic reviews were not included due to the higher risk of bias.²³

Selection of trials. The electronic database search yielded 5355 articles. An additional 13 articles were found using reference list scanning, citation tracking, and a search of mindfulness research monthly. Overall, 656 duplicates were removed leaving 4712 articles. Two reviewers independently

**Fig. 1.** Flow of information through the review. Abbreviation; RCT, randomized controlled trial.

applied the selection criteria to the abstracts and titles. Where there was inadequate information to determine eligibility full texts of the articles were accessed and the criteria reapplied. Disagreements between the two reviewers were resolved through discussion regarding the applicability of the study to the review question. Of the 4712 articles, 4645 were excluded following screening using the title and abstract. The full text of 67 articles were obtained and assessed for eligibility. Further, 48 were excluded mostly because there was no control group $n = 14$, they used qualitative analysis $n = 11$, they were comment pieces $n = 8$ and non-English $n = 4$. A total of 19 were selected for this review (Fig. 1).

Risk of bias. Assessment of risk of bias was performed to determine the level of confidence that could be attributed to trial results. The Cochrane risk of bias tool was chosen to assess the internal and external validity of the articles used. This tool consisting of six domains is recommended by the Cochrane collaboration for randomized and non-randomized control trials. Domains include sequence generation, allocation sequence concealment, blinding, incomplete outcome data, selective outcome reporting, and “other” potential sources of bias.²³ The domain specification of eligibility criteria was added to assess external validity.

Trials were not included or excluded based on the risk of bias assessment. Two reviewers assessed the trials independently. Any differences were discussed and a consensus reached.

Data extraction. Descriptive information relating to each trial was extracted regarding the number of participants, their presenting characteristics and the interventions used. Continuous treatment effects and associated 95% confidence intervals were calculated using the Hedges- g standardised mean difference (SMD).²³ The SMD was chosen as it allows comparison of effect sizes from different outcome measures both between and within trials.²⁴ The SMD was calculated using group mean scores and pooled standard deviations (SDs) at the follow-up time of interest. When these values were not reported, they were estimated from mean change scores, baseline SDs, median values,²³ or SDs derived from the standard error or range.²⁵ Negative SMD values were used to indicate treatment effects favouring the group receiving mindfulness. Standardised mean differences of 0.2, 0.5, and 0.8 were considered thresholds for small, moderate, and large effect sizes, respectively.²⁶

Data analysis. Pooling of data via meta-analysis was conducted using Review Manager 5.2. Trials in each planned comparison were assessed for statistical heterogeneity, which was considered likely if $p < .05$ were obtained on the chi-square test, or if the I^2 statistic was $> 25\%$. A random effects meta-analysis was then undertaken.^{23,27} Caution was taken drawing conclusions from meta-analysis, where clinical or statistical heterogeneity was present. Funnel plots were created to test for publication bias using review manager 5.2 when there were 10 or more studies.²³

RESULTS

We found 19 studies involving a total of 1815 participants.

Characteristics of Included Trials

The characteristics of included studies are listed in Table 2. A total of 12 studies were randomized controlled trials,^{28,30,34,36–44} while 7 were non-randomized studies.^{31–33,45–48}

Participants included students studying medicine (10 studies), nursing (4 studies), social work (1), psychology (1), medicine or psychology (1) and health sciences including podiatry, occupational therapy, physiotherapy, and graduate nursing (2).

Overall, 10 studies were based on Mindfulness-Based Stress Reduction (MBSR)²⁰ and involved 1.5–2.5 hour sessions for 7–10 weeks and included didactic teaching on the theory of stress, mindfulness meditation, mindful movement, application of mindfulness, and home practice.^{28,30,31,38,40,43–46,48} One study was based on MBSR, but was shorter involving one and half hours for four weeks.³⁹ Three studies used a program called Mindful Gym, also a shorter program involving two to three hour sessions per week, for four to five weeks, adapted from mindfulness-based cognitive therapy and MBSR.^{33,34,42} Two studies used a DVD or CD-delivered program followed independently by the participants. These comprised a five-week DVD delivery of Mindful Gym,³⁴ and a 30-minute-guided mindfulness practice on CD followed daily for eight weeks.³⁷ One study used a short intervention comprising 10 minutes mindfulness training and five minutes discussion integrated into 28 counseling skills classes.⁴⁹ Three studies used only mindful meditation for 28–30 days. This was done as a group with a CD for 20 minutes,⁴¹ as a group led by an instructor for 10 minutes⁴⁷ and as independent practice after 2 training sessions in the meditation practice.³⁶ Control groups included nothing (10), wait list (4), initial one hour lecture then nothing, activity in another room, usual care, Mindful Gym DVD six months post-conclusion of study and seminar series on complimentary medicine.

One study integrated the training into the core curriculum³² and one study offered the course as an elective.⁴⁵ Participants in all other mindfulness programs were volunteers participating in addition to their studies.

In four studies students in the intervention group had higher initial anxiety than the control. Students may have self-selected based on anxiety in three of the studies as the control was matched after the experimental group was determined,⁴⁶ was the remaining cohort³¹ or included students enrolled in an alternative elective.⁴⁵ Three RCTs had higher stress and anxiety in both intervention and control compared to normative data^{37,39,42} again students with higher levels of stress and anxiety may have self-selected for the study.

Outcome measures included the assessment of mindfulness, anxiety, depression, stress, mood state, empathy, self-efficacy, and resilience.

All studies measured post-intervention, seven studies then followed up between three weeks and nine months post-intervention.^{28,30–32,34,37,42,46}

Table 2. Summary of Included Trials, $n = 19$

Author	Study Type	Population	Control	Intervention	Outcomes Analyzed	Time Frame Measurement	Outcomes
Astin ²⁸	RCT	$N = 14$ Behavioral medicine	$N = 14$ Behavioral medicine Wait list control	MBSR, Kabat Zinn 8 wk/2 h Home = 45/d Med-body scan, sitting med, hatha yoga, and didactic presentations on stress No eight hour retreat	Hopkins SC-90 R (SLC-90_R) + additional items scale 5 sleeping and eating GSI, SCL, INSPIRIT, and daily compliance diaries Questioned whether received something of value and what that was.	Pre Post at eight weeks 6–9 months post (but only 5 of 12 participants and only GSI)	↓ Overall psych symptoms, ↑ sense of control and use of accepting or yielding mode of control, higher scales on measures of spiritual experiences in intervention gp post +ve changes maintained on GSI at six to nine months
Barbosa et al. ⁴⁶	Non-RCT, matched control	$N = 12$ (Pod, OT, PT, nursing, and physician assistant).	$N = 14$ (Pod, OT, PT, Nursing, and Physician Assistant). Control— nothing	MBSR eight weeks/ two and a half hours + eight-hour retreat Mindful awareness daily activities and communication Med home prac 35 minutes formal MF, 5–15 minutes informal practice Mindful movement qi gong, body scan, yoga, sitting med mindful awareness of daily routines/ communication	BAI, JSPE, and MBI	Baseline post at week 8 Follow-up week 11	↓ Anxiety in intervention gp week 8 and 11 Increase in empathy intervention gp week 8, but not at week 11, no difference in burnout scale weeks 8 or 11 Difference at baseline intervention mean mode anxiety, control mean mild anxiety

de Vibe et al. ²⁹	RCT	<i>N</i> = 144 Medical/ psychology	<i>N</i> = 144 Medical/ psychology	MBSR Kabat Zinn one and a half hours × seven weeks, six hours session, 30 minutes daily MF prac Physical/mental exercise Didactic teaching re- stress Facilitated group MF prac in class Home prac	GHQ, MBI, PMSS, SWB, FFMQ, Self- report practice and # classes attended	Pre- and Post- intervention Online	Moderate decrease mental distress, small increase subjective well- being and mindfulness facet in the intervention group No effect burnout Higher level of attendance and practice ↑ effect of intervention in both med and psych students, effects found irrespective of med or psych Significant effects were only found in female students
Erogul et al. ³⁰	RCT	<i>N</i> = 29 first yr medicine	<i>N</i> = 30 first yr medicine Control— nothing	MBSR involved 75 minutes, once/week for eight weeks gp instruction and 20 minutes individual home med/day × eight weeks. MBSR involved teaching MF med, body scan and breathing-based yoga and cognitive curriculum After week 4 shifted from guided to self-med. one × full day retreat (between week 7 and 8)— immerse in mindfulness	PSS, SCS, and RS Self-report on extent of home med	Pre and immediately post-intervention and six months post-intervention	↓ Perceived stress at study end, not a six months post ↑ self-compassion scores at end and six months post RS scores no change at end or 6 months post

Table 2 (*continued*)

Author	Study Type	Population	Control	Intervention	Outcomes Analyzed	Time Frame Measurement	Outcomes
Finkelstein et al. ³¹	Control trial	<i>N</i> = 30 Second yr medicine	<i>N</i> = 46 Second year medicine Control—nothing	Mind–body skills course 10 week/two-hour sessions Weekly large group presentation 30 minutes + small group (8–10) 90 minutes Homework—exercise 30 minutes/3 × week, med 15 minutes × 6/week	SCL-90 Anxiety subscale, POMS, the two item depression index and PSMS	Pre and Post-intervention three months follow-up	↓ in anxiety in intervention maintained three months post-course Difference at baseline intervention students had higher initial anxiety than controls
Gockel et al. ³²	Cohort control	<i>N</i> = 38 (SW grad entry first yr) Core curriculum clinical interviewing class	<i>N</i> = 94 (remaining SW cohort) Core curriculum clinical interviewing class Control—nothing	10 minutes MF training (informed by MBSR) includes imagery and concentration meditations, 5 minutes discussion In 28 clinical interviewing classes Over 10 weeks Total seven hours focus on self-improvement and using prac in clinical work	20 item state subscale of STAI RRQ, FMI, MAAS, NSCS, IRI Counselor Activity Self-Efficacy Scales (CASES)	Pre Post-intervention three-month follow-up	↑In counseling self-efficacy and key to clinical learning process in intervention gp , no difference in well-being , no difference mindfulness post-increase mindfulness and no difference MASS at follow-up
Jain et al. ³⁹	RCT	<i>N</i> = 27 MBSR <i>N</i> = 24 relaxation (full time medical	<i>N</i> = 30 control Wait list control	MBSR group one and a half hour × four weeks	BSI, PSOM Practice log Emotion report daily	Two weeks prior and two weeks post	↓ Distress and ↑ improve mood states in MBSR and relaxation gps

		and health students		Body scan, sitting med, yoga, walking med, loving kindness med tapes, manuals, theory and homework assignments six-hour retreat	INSPIRIT MCSF		Decrease in distractive and ruminative thoughts/behaviors in MBSR gp only
		self-identified as experiencing stress)		Somatic relaxation group one and a half hour × four weeks PMR, breathing, guided imagery tapes, manuals and homework six-hour retreat Control			
Kang et al. ⁵⁹	RCT	<i>N</i> = 16	<i>N</i> = 16	MBSR × eight weekly, one and a half to two-hour sessions MF med-body scan, breathing and walking med followed by self-reflection	BP, HR, self-administered questionnaire, PWI-SF, STAI, and BDI	Pre and one week following intervention	Control and intervention started with one and a half hour lecture stress and coping, no diff depression scores, decrease stress and anxiety scores in intervention gp . Difference at baseline intervention students had higher initial stress and anxiety scores
		Nursing (during clinical training)	Nursing (during clinical training) Initially same one and a half hr lecture and physical motion each session				
Keng et al. ³³	Cohort control	<i>N</i> = 77 Fourth year medicine (psych rotation) Self-selected gp	<i>N</i> = 57 Fourth yr medicine (psych rotation)	four weeks × three hour sessions of mindfulness-based stress management (adapted from MBCT	MAAS, PSS, DASS-21, GHQ-12, SHS, and SWLS	Pre and immediately post	Improvements in depressive symptoms, perceived stress, anxiety, subjective happiness and

Table 2 (*continued*)

Author	Study Type	Population	Control	Intervention	Outcomes Analyzed	Time Frame Measurement	Outcomes
			Self-selected gp Control—nothing	and MBSR) —“Mindful Gym” Didactic teaching, mindful and loving kindness meditation, gratitude, mindful movement and application of principles 10–15 minutes daily MF exercises.(guided by instructions on DVD) 15–20 per group			satisfaction with life Looked at effect of trait mindfulness and whether mediated mindfulness.
Paholpak et al. ⁴¹	RCT	<i>N</i> = 30 Medicine (psych rotation)	<i>N</i> = 28 Medicine (psych rotation) Control—activity in another room, for example, reading	Guided mindful awareness of breathe meditation, daily, for 20 minutes × 28 days CD in group	SCL-90, WMS-1 Ravens advanced progressive matrices and academic achievement using psychiatry MCQ examination score	Pre and day 1 post-intervention. Course exam at end of rotation	No diff psychiatric symptoms, memory function, intellectual performance and academic result
Phang et al. ³⁴	RCT	<i>N</i> = 38	<i>N</i> = 38	Five-week DVD-delivered mindfulness-based stress management (adapted from MBCT and MBSR) —“Mindful Gym” 30 minutes briefing, then no other contact DVD —500 slides with audio/	MAAS, PSS, DASS, GSE, and one item practice compliance questionnaire	One week prior	One week post = ↓ perceived stress, depression, anxiety and stress symptoms (mental distress) ↑ levels MF and self-efficacy six months post = changes not maintained

		first to third year medicine	first to third year medicine Control— nothing	video instructions organized in five modules (five weeks). Didactic teaching, gratitude, mindful and loving kindness meditation, mindful movement and application of principles three to five minutes daily practice		Follow-up at one week and six months post	Less mindful practice at follow- up
Phang et al. ³⁵	RCT	<i>N</i> = 37 First to third year medicine	<i>N</i> = 38 First to third year medicine Control— received the mindful gym program DVD six months post the study conclusion (after follow- up)	Five week × two hour sessions of mindfulness-based stress management (adapted from MBCT and MBSR)—“ Mindful Gym” Didactic teaching, gratitude, mindful and loving kindness meditation, mindful movement and application of principles Three to five minutes daily practice guided by instructions on DVD) 10 participants per group	MAAS, PSS, GHQ, GSE one item questionnaire to assess weekly practice compliance	One week Pre one week post six months post	One week post—↓ perceived and mental distress Improvements in MF and self-efficacy Six months post ↑ self-efficacy Higher mental distress than non- participants
Ratanasiripong et al. ³⁶	RCT	<i>N</i> = 29 biofeedback	<i>N</i> = 31	Biofeedback gp two training sessions on how to use equipment.	PSS SAS from STAI	Pre and immediately post	Biofeedback—↓ anxiety levels, maintaining stress levels. Mindfulness—↓ anxiety levels ↓ and perceived stress levels
		<i>N</i> = 29 mindfulness meditation	second year nursing Control— nothing	Mindfulness gp two training sessions			

Table 2 (continued)

Author	Study Type	Population	Control	Intervention	Outcomes Analyzed	Time Frame Measurement	Outcomes
		Second yr nursing		on how to do Vipassana med. Both to use three times/day for four weeks and record in logbook			
Rosenzweig et al. ⁴⁵	Non-RCT	<i>N</i> = 140 Second year medicine 1 of 10 elective seminar series	<i>N</i> = 162 Second year medicine Control alternate/complimentary medicine elective seminar series	MBSR 10 weekly × 90 minutes sessions, body scan, breath awareness yoga, eating med, and walking meditation, Guide4d imagery tape x 20 minutes formal med Prac six days/week	POMS (six subscale scores and TMD)	Start and end of course	Decrease in total mood disturbance and in four subscales in intervention gp Difference at baseline Intervention gp greater mood disturbance
Shapiro and Schwartz ⁴³	RCT, matched	<i>N</i> = 37 Pre-med, first and second year med (two classes <i>N</i> = 18 and <i>N</i> = 19 different facilitator) Offered as enrichment elective	<i>N</i> = 41 Pre-med, first and second year med matched wait list control	MSSR seven × two and a half hours MF formal practice/application to daily life (Kabat Zinn), sitting MF, body scan, hatha yoga, loving kindness, mindful listening and empathy, didactic material on stress and weekly home practice/daily journals	ECRS, Hopkins symptom checklist SCL-90-R, GSI depression subscale four of SCL-90, STAI form 1, INSPIRIT, daily compliance journal and evaluation packets	Before and after course Secondnd intervention exam time	Decrease in state and trait anxiety, depression, GSI and increases in spirituality and empathy in intervention gp

Song and Lindquist ⁴⁴	RCT	<i>N</i> = 23 Nursing	<i>N</i> = 21 Nursing Wait-listed control	MBSR 2 hours/week for eight weeks Consisted of guided instruction on MF med, gentle stretching and group discussion, and home assignments	DASS-21 MAAS—Korean Version	Before After	↓ Depression, anxiety and stress ↑ Mindfulness
Warnecke et al. ³⁷	RCT	<i>N</i> = 31 Medical last two years Control and intervention similar at baseline, however, participants in trial ↑ stress and anxiety compared to normative data	<i>N</i> = 34 Medical last two years Control—usual care	30-minute-guided mindful practice CD independently followed daily/eight weeks adherence diary	PSS, DASS	Baseline End of intervention eight weeks Follow-up 16 weeks	↓ Stress and anxiety in intervention gp,
Yamada and Victor ⁶⁰	Non-RCT	<i>N</i> = 37 UG upper level psychology	<i>N</i> = 23 UG upper level psychology Control—finished classes 10 minutes earlier	Brief introductory material provided at first session 10-min-guided sitting MF meditation at start of Psych class × 2/wk × 15 weeks led by instructor	<i>Psychological well-being</i> —FMI, MAAS, SCS, RRQ, PSS and STAI <i>Sense of capacity for learning</i> —evaluation of mindful awareness practices <i>Learning outcomes</i> —total scores = class assessments, for example, peer evaluations and exams	Pre- and post-intervention 3 × academic assessments during 15-week semester	↑ In mindful awareness traits, ↓ in rumination, ↓ state anxiety in intervention gp, no diff in academic performance, but 81% of students reported +ve effects of MAPS on learning

Table 2 (continued)

Author	Study Type	Population	Control	Intervention	Outcomes Analyzed	Time Frame Measurement	Outcomes
Young et al. ⁴⁸	Non-RCT cohort control	15 third-year nursing students	15 third-year nursing students Control—nothing	MBSR 8 weeks course yoga, breathing and body scan being mindful	SF36 health survey, SCL-90 and MMPI (Symptom checklist) Antonovsky's orientation to life	Pre and post-intervention	Small to medium effect for health related, sense of coherence and physical symptoms Psychological symptoms greatest ↓

Med = meditation; MF = mindfulness; MBSR = mindfulness-based stress reduction; SCI = Shapiro control inventory; INSPIRIT = index of core spiritual experiences; BAI = Burns anxiety inventory; STAI = state trait anxiety inventory; RRQ = reflection rumination questionnaire; FMI = Freiburg mindfulness inventory; MAAS = mindful attention awareness scale; NSCS = Neff's self-compassion scale; SCS = self-compassion scale; BSI = brief symptom inventory; PSOM = positive state of mind scale; PWI-SF = psychological well-being index-short form; BDI = Beck depression inventory; WMS-1 = Weschler memory scale; JSPE = Jefferson scale of physician empathy; MBI = Maslach burnout inventory; GHQ = general health questionnaire; PMSS = perceived medical stress scale; SWB = student well-being; FFMQ = five facet mindfulness questionnaire; SCL-90 = self-checklist 90; MCSF = Marlowe Crowne SF; POMS = profile of mood states; TMD = total mood disturbance score; GSI = general severity index; EORS = empathy construct rating scale; FMI = Freiburg mindfulness inventory; SCS = self-compassion scale; RRQ = rumination reflection questionnaire; PSS = perceived stress scale; RLI = interpersonal reactivity index; PSS = perceived stress scale; DASS = depression, anxiety & stress scale; DASS-21 = depression, anxiety & stress scale short version; PSMS = perceived stress of medical school instrument; CASES = counselor activity self-efficacy scales; MAPS = mindful awareness practices; SAS = state anxiety scale; RS = resilience scale; SHS = subjective happiness scale; SWLS = satisfaction with life scale.

Risk of Bias

Overall there was moderate methodological quality. No study blinded the participants, although this is not surprising due to the nature of the intervention. Only six studies demonstrated allocation concealment. Only seven studies demonstrated random allocation. Blinding of outcome assessment (16 trials), selective reporting (16 trials), and clear eligibility criteria were the most commonly satisfied criteria. The risk of bias of each study is shown in Fig. 2.

Effectiveness of Mindfulness

Of the 13 comparisons of interest (including mindfulness, anxiety, stress, self-efficacy, and resilience across two follow-up time points), 10 contained at least two trials. Seven comparisons satisfied our preset criteria for statistical homogeneity to allow for valid meta-analysis. Two exhibited some heterogeneity and one significant statistical heterogeneity so caution was used interpreting the meta-analysis.

Effect of mindfulness on mindfulness. Six studies (677 participants) evaluated mindfulness post-intervention. Meta-analysis (Fig. 3) showed a significant effect favouring mindfulness, (SMD = -0.24 ; 95% CI: -0.39 to -0.09 ; $p < .01$). Three studies demonstrated low risk, one moderate risk and two moderate to high risk of bias.

Two studies (207 participants) followed up post-intervention.^{32,42} Meta-analysis showed no significant difference (SMD = -0.24 ; 95% CI: -0.53 to 0.05 ; $p = .10$) at follow-up. Risk of bias is low and moderate to high.

Effect of mindfulness on anxiety. Overall, 11 studies (679 participants) evaluated anxiety post-intervention. Meta-analysis (Fig. 4) showed a significant effect favouring mindfulness (SMD = -0.44 ; 95% CI: -0.59 to -0.28 ; $p < .01$). One study demonstrated high risk, one moderate to high risk, five moderate risks, and six low risk of bias. Visual analysis of the funnel plot did not reveal any obvious evidence of publication bias.

Two studies (114 participants) evaluated anxiety at follow-up.^{31,37} Meta-analysis showed no significant effect, with the decreases in anxiety achieved post-intervention being maintained at follow-up (SMD = -0.65 ; 95% CI: -1.82 to 0.52 ; $p = .27$). However, there was evidence of significant statistical heterogeneity for this comparison, meaning the validity of meta-analysis may be questionable in this case. Two studies did not provide sufficient data to be included in the meta-analysis.^{28,34} Astin²⁸ reported significant improvements in anxiety post-intervention that were maintained at follow-up, while Phang et al.³⁵ reported improvements that were not maintained at follow-up.

Barbosa et al.⁴⁶ did not provide sufficient data to include in the post-intervention or follow-up meta-analysis. Significant decreases in anxiety immediately after the program which were maintained 3 weeks later were reported.

Effect of mindfulness on depression. Seven studies (430 participants) evaluated depression post-intervention. Meta-analysis (Fig. 5) showed a significant effect favouring

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Astin (1997)	+	+	+	+	+	+	+
Barbosa et al (2013)	+	+	+	+	+	+	+
Erogul et al (2014)	+	+	+	+	+	+	+
Finkelstein et al (2007)	+	+	+	+	+	+	+
Gockel et al (2013)	+	+	+	+	+	+	+
Jain et al (2007)	+	+	+	+	+	+	+
Kang et al (2008)	+	+	+	+	+	+	+
Keng et al (2015)	+	+	+	+	+	+	+
Paholpak et al (2012)	+	+	+	+	+	+	+
Phang et al (2015a)	+	+	+	+	+	+	+
Phang et al (2015b)	+	+	+	+	+	+	+
ratanasiripong et al (2015)	+	+	+	+	+	+	+
Rosenzweig et al (2009)	+	+	+	+	+	+	+
Shapiro et al (1998)	+	+	+	+	+	+	+
Song & Lindquist (2015)	+	+	+	+	+	+	+
Vibe et al (2013)	+	+	+	+	+	+	+
Warnecke et al (2011)	+	+	+	+	+	+	+
Yamada et al (2012)	+	+	+	+	+	+	+
Young et al (2001)	+	+	+	+	+	+	+

Fig. 2. Risk of bias summary—review of authors' judgements about each risk of bias item for each included study.

mindfulness (SMD= −0.54; 95% CI: −0.83 to −0.26; $p < .01$). There was, however, evidence of some heterogeneity for this comparison, meaning the validity of meta-analysis may

be questionable in this case. One study had high risk, three had medium risk and four low risk of bias.

Effect of mindfulness on stress. In all, 11 studies (954 participants) evaluated stress post-intervention. Meta-analysis (Fig. 6) showed a significant effect favouring mindfulness (SMD = −0.44; 95% CI: −0.57 to −0.31; $p < .01$). Four studies had moderate risk and six had low risk of bias. Visual analysis of the funnel plot did not reveal any obvious evidence of publication bias.

Young et al.⁴⁹ did not provide data to include in meta-analysis. This study looked at the effect of MBSR in a group of nursing students and reported a small to moderate decrease in variables indicative of stress in the intervention group.

Three studies (198 participants) evaluated stress at follow-up.^{30,31,42} Meta-analysis showed no significant effect on stress (SMD = −0.22; 95% CI: −0.61 to 0.17, $p = .27$) indicating the significant decreases in stress post-intervention were maintained at three months follow-up. There was, however, evidence of some heterogeneity for this comparison, meaning the validity of meta-analysis may be questionable.

Phang et al.³⁵ did not provide data to include in the meta-analysis, but reported decreases in stress post the DVD-delivered program were not maintained at follow-up.

Effect of mindfulness on mood. Four studies (698 participants) evaluated mood post-intervention. Meta-analysis (Fig. 7) showed a significant effect favouring mindfulness (SMD = −0.36; 95% CI: −0.51 to −0.21; $p < .01$). All studies were of moderate to low risk and used MBSR or mind body programs.

Effect of mindfulness on empathy. Two studies (138 participants) evaluated empathy post-intervention. Meta-analysis (Fig. 8) showed a significant effect in favor of mindfulness (SMD = −0.39; 95% CI: −0.73 to −0.04; $p = .03$). The study with a significant effect had low risk of bias and used MBSR program. The study with the non-significant effect used only mindful meditation and was with moderate risk of bias.

Effect of Mindfulness on self-efficacy. Two studies (151 participants) evaluated self-efficacy post-intervention. Meta-analysis (Fig. 9) showed a significant effect in favor of mindfulness (SMD = −0.82; 95% CI: −1.15 to −0.49, $p < .01$). Both studies had a low risk of bias.

Phang et al.³⁵ reported higher self-efficacy at follow-up.

Effect of mindfulness on resilience. One study (57 participants) evaluated resilience post-intervention and at follow-up.³⁰ There was no significant effect in favor of mindfulness post-intervention (SMD = −0.27; 95% CI: −0.80 to 0.25, $p = .30$) or at follow-up (SMD = −0.27; 95% CI: −0.97 to 0.08; $p = .30$).The lack of significance may have been due to low numbers and the study being underpowered. This study had a low risk of bias.

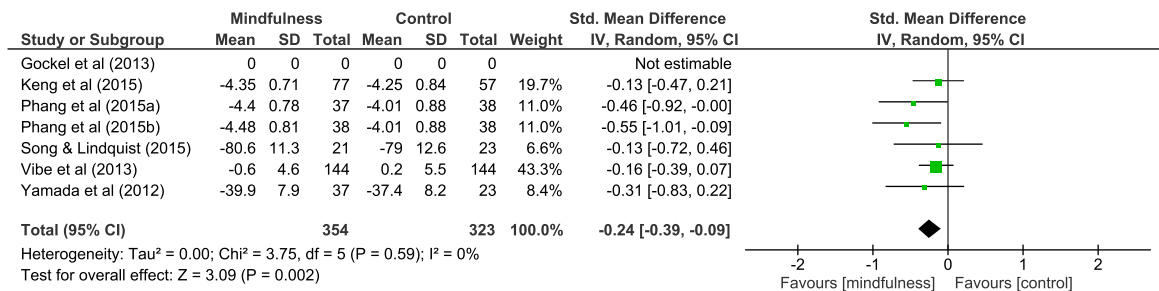


Fig. 3. Mindfulness post-intervention.

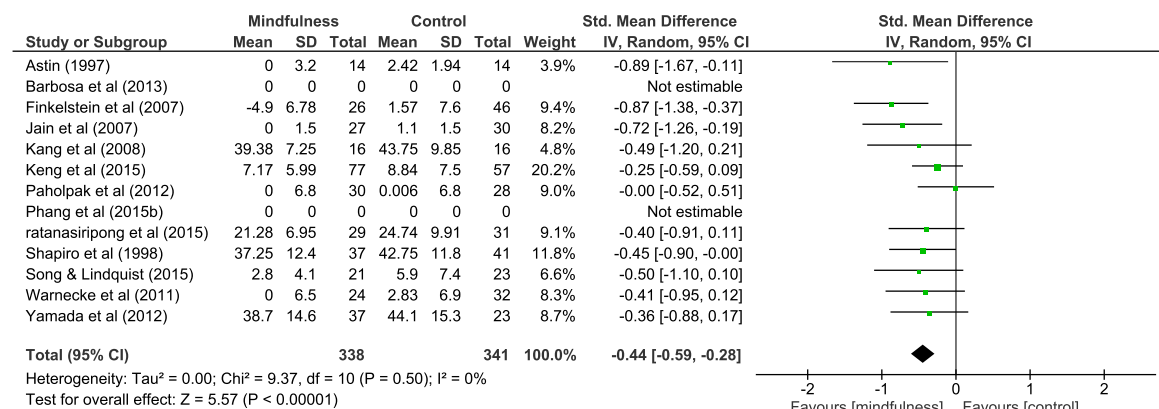


Fig. 4. Anxiety post-intervention.

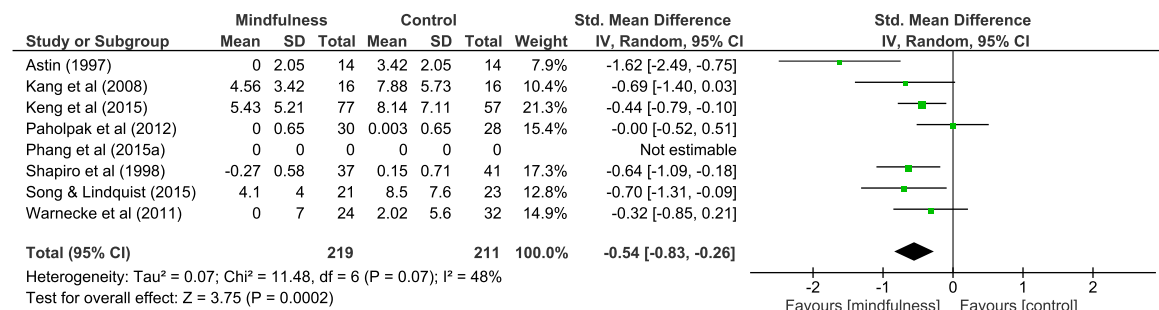


Fig. 5. Depression post-intervention.

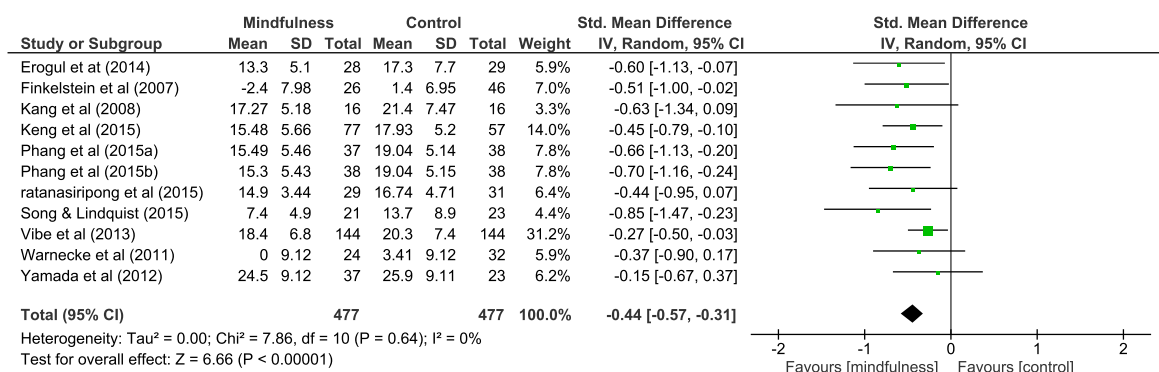


Fig. 6. Stress post-intervention.

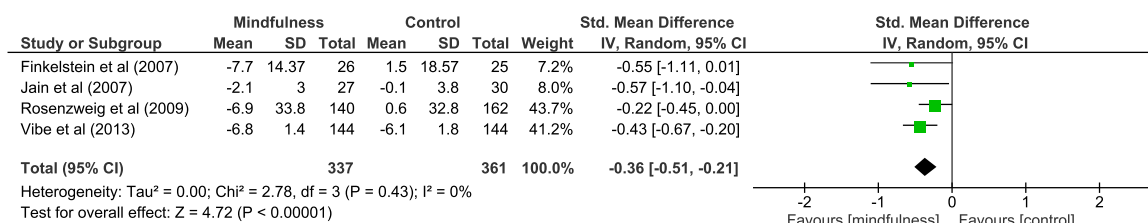


Fig. 7. Mood post-intervention.

Effect of mindfulness on academic performance. Two studies, one with moderate and one with low risk of bias, measured academic performance. One study⁴⁷ found no significant difference in the final results of a 15-week psychology subject, although students reported positive effects on their learning. Another study⁴¹ found no difference in memory function, intellectual performance or academic achievement. Both studies used only mindfulness meditation not the application of mindfulness.

DISCUSSION

This review of controlled studies has identified positive outcomes of mindfulness training in relation to decreasing anxiety, stress and depression, and increasing positive mood states, self-efficacy, mindfulness, and empathy in health profession students. Changes in anxiety and stress were maintained at follow-up. Self-efficacy furthermore improved at follow-up. In 7 of the 19 trials data were collected in a high stress period for students, just prior to exams. Positive results at this time indicate mindfulness training could be an effective tool to cope with potential stressors of university life.

Stress, anxiety, and depression can have a negative effect on health and a student's capacity to study and perform in clinical practice.^{50–52} By decreasing stress and anxiety and increasing self-efficacy, mindfulness, and empathy and mindfulness-based interventions have the potential to improve student psychological well-being^{53,54} and to potentially facilitate a more patient-centered and psychosocial approach to care,¹⁹ including an increased ability to be present, open, and responsive to clients.⁴⁹ Professional practice threshold standards in the health sciences related to professional, communicator, and reflective practitioner roles include competencies in managing mental health and resilience, communication, and client centered model of practice.⁵⁵ The integration of mindfulness training into a health profession program could foster these competencies.

Factors including the content, the mode of delivery, the total length of time the students engage with mindfulness

meditation and mindfulness practice, the student professional group, where in the course of study the intervention is situated and whether the program is optional or compulsory may contribute to the effectiveness of the intervention.

MBSR had a larger effect than mindful meditation alone. Taking a multidimensional approach including presenting the evidence supporting mindfulness in stress reduction, introducing different mindful practice options (body scan, mindful meditation, and mindful movement) and discussing the application of mindfulness and sharing experiences with peers, provides a range of ways for the individual to engage with mindfulness.⁵⁶ This may improve uptake of the practice and the application of mindfulness in daily life, study and clinical practice.

Both the longer MBSR and shorter MBSR and Mindful Gym programs were effective. The shorter (five weeks) Mindful Gym was delivered in person or as a five week DVD-delivered program. Both were effective in increasing mindfulness and self-efficacy and decreasing stress and mental distress.^{34,42} The findings from the DVD-delivered program are consistent with the trend of decreasing anxiety, stress, and depression with a 30-minute CD-delivered daily mindful practice program.³⁷ Delivering via DVD or CD are potentially a cost-effective way of providing MBSR program to health science students.

A MBSR program requires trained staff, a large time commitment and costs associated with running small groups. Shorter, single component (e.g., mindfulness meditation alone) programs guided by a facilitator, presented online or completed independently at home could be easily and cost-effectively introduced into the higher education context. However, furthermore research, with larger numbers, is required to clarify the efficacy of these interventions. Results from this systematic review showed mindfulness meditation alone had no effect on anxiety and depression in one study,⁴¹ and a non-significant trend decreasing stress and anxiety in two others. Whether the mindfulness meditation was practised independently³⁶ or was led by an instructor in a group setting,⁴⁷ similar results were produced in the studies with trends favouring mindfulness.

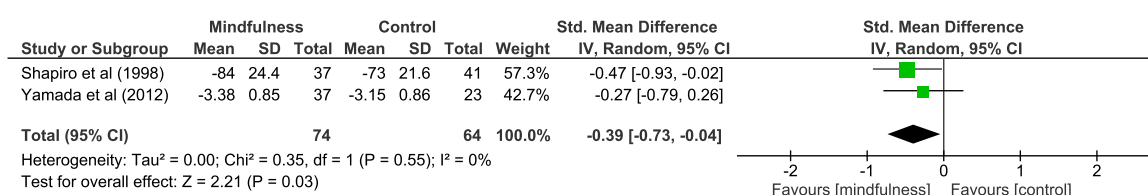


Fig. 8. Empathy post-intervention.

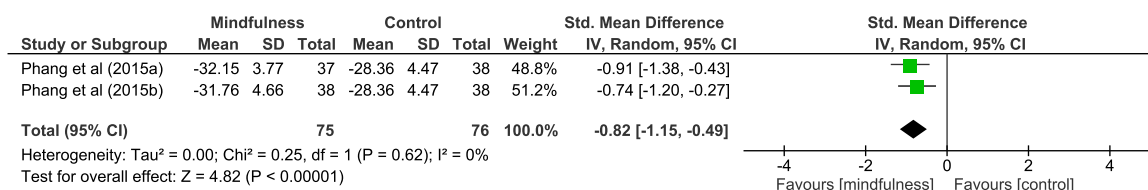


Fig. 9. Self-efficacy post-intervention.

Time spent in mindfulness practice may influence effectiveness. The combined time spent in formal and informal mindfulness practice in the MBSR programs was greater than the practice in the shorter mindfulness meditation only programs (5–14 hours) and may have contributed to larger effect sizes in these studies. Adherence to independent meditation practice, which may be challenging for students with high study loads, may also impact effectiveness.

The amount of home practice commonly decreased following the intervention and may explain why levels of stress and anxiety did not decrease and mindfulness did not increase at follow-up.^{30,34,42} Identifying barriers to regular practice and developing a system of reminders and the use of easily accessible apps may enable continuing benefit.

Decreases in stress and anxiety and increases in mood occurred irrespective of student groups—medical, psychology, nursing, and allied health (podiatry, occupational therapy, and physiotherapy) when the intervention was based on MBSR or MBCT. These effects were seen in South-East Asian, American, and Australian contexts.

Interventions occurred during the early years of a health professional training program, the later years, across multiple years, in graduate programs and during clinic training. As there was no standardization between programs, it is not possible to compare the effect of the timing of the intervention.

There was no obvious difference in the positive results of the studies which were run additional to the curriculum, as an elective seminar series or an enrichment elective. In contrast, there was no change in well-being and mindfulness in the one study in this review where mindfulness was integrated into the core curriculum.⁴⁹ The intervention was short (total seven hours) and included a focus on clinical skills not just well-being that may explain the lack of effect. Optional programs are associated with higher levels of student satisfaction⁵⁷ although factors like the timing of the program and the perceived relevance of the program, including possible increased relevance during clinical placements, may influence this.

In three of the seven non-randomized trials the intervention group had higher initial anxiety than the control, which could be indicative of the students self-selecting based on high levels of stress. In 3 of the 12 RCTs both the intervention and control group had higher stress and anxiety compared to normative values, which may represent the higher levels of anxiety and depression commonly observed in medical students or self-selection. This is supported by van Dijk who found medical students interested in mindfulness training had more psychological distress than their

non-interested peers.⁵⁸ Although the interventions were successful in decreasing anxiety and mood disturbance in both intervention groups with higher initial levels and those with similar initial levels of stress and anxiety to the controls, results may have been affected overall if students were self-selecting for the intervention. Having identified a need, the students may have been more motivated and engaged in the process. Due to higher baseline levels of stress and anxiety, the mindfulness training may have had a greater effect on mental distress and well-being as described in relation to increased baseline levels of neuroticism in a group of medical and psychology students.³⁸ Programs allowing self-selection by students with higher self-perceived stress may be an effective way to ensure those who will benefit most from a stress reduction intervention have been targeted if this is the primary aim of the intervention.

There is a growing interest in the application of mindfulness in education for effective learning. Only two studies with small numbers specifically addressed outcomes related to student learning with no difference in final academic results; however, students did report positive effects on their learning.

Students cannot be forced to be mindful. The wider the appeal of a program, the more potential there is for student to engage and ultimately practice mindfulness. If mindfulness was introduced as core curriculum a focus on both stress management, enhancing learning and improving professional practice would have potential universal application for all health professional students.

LIMITATIONS

The focus on quantitative data in this review means the lived experience is not explored, which would have added depth to this data. The low numbers of studies in the meta-analysis for empathy and self-efficacy post-intervention and for all the follow-up outcomes (mindfulness, anxiety, stress and self-efficacy) means the strength of our conclusions are limited for these outcomes. Meta-regression, when there was heterogeneity among studies, was not performed due to having less than 10 studies in the meta-analysis. Testing for publication bias using a funnel plot was only performed for two meta-analyses, as there were less than 10 studies in the meta-analysis of all other outcome measures and the power of the tests consequently too low to distinguish asymmetry.²³

AUTHOR CONTRIBUTIONS

All authors were involved in planning, analysis, and article construction.

APPENDIX 1

Search Strategy Medline

Mindfulness Search Final Medline

1. Students, Premedical/ or Students, Dental/ or Students, Nursing/ or Students/ or Students, Medical/ or Students, Public Health/ or Students, Health Occupations/ or Students, Pharmacy/
2. (students or health professional").mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]
3. Mindfulness/ or Awareness/ or Meditation/
4. (mindfulness or meditation or "mindfulness-based stress reduction" or "mindfulness-based cognitive therapy" or "embodied ADJ mindfulness" or Zen or Vapassna).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]
5. 1 or 2
6. 3 or 4
7. Mindfulness/
8. Awareness/
9. Stress, Physiological/ or Stress, Psychological/
10. Anxiety/
11. Depression/
12. Self Care/
13. Cognition/
14. Self-Assessment/
15. Empathy/
16. (mindfulness or stress or anxiety or depression or "self care" or "self compassion" or "coping strategy" or "psychological well being" or cognition or attention or engagement or" interpersonal sensitivity" or empathy or "reflective practice").mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]
17. 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16
18. 5 and 6 and 17

APPENDIX 2

Risk of Bias Table

Warnecke et al.

External validity		
Eligibility criteria specified	Low risk	Medical students in final two years study Excluded if involved in pilot or K10 score > 30
Internal validity		
Random sequence (Selection bias)	Low risk	"randomized centrally using block randomization" probably done
Allocation sequence (Selection bias)	Low risk	"Packs were prepared centrally" "All packs contained a CD cover so that trial packs in the two arms of the study looked identical" Query were they unsealed Done to "conceal allocation" so probably OK
Blinding of participants and personnel (Performance bias)	High risk	RA who scored and entered data and statistician blinded Participants not blinded
Blinding of outcome assessment (Detection bias)	Low risk	Self-report questionnaire Not blinded, but unlikely to influence outcome

The Cochrane risk of bias tool. Example of process to assess risk of bias.

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