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Interventions to promote medical student well-being: an overview of systematic reviews

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ABSTRACT

Objective To conduct an overview of systematic reviews that explore the effectiveness of interventions to enhance medical student well-being.

Design Overview of systematic reviews.

Data sources The Cochrane Library of Systematic Reviews, MEDLINE, APA PsychInfo, CINAHL and Scopus were searched from database inception until 31 May 2023 to identify systematic reviews of interventions to enhance medical student well-being. Ancestry searching and citation chasing were also conducted.

Data extraction and synthesis The Assessing the Methodological Quality of Systematic Reviews V.2 tool was used to appraise the quality of the included reviews. A narrative synthesis was conducted, and the evidence of effectiveness for each intervention was rated.

Results 13 reviews (with 94 independent studies and 17 616 students) were included. The reviews covered individual-level and curriculum-level interventions. Individual interventions included mindfulness (n=12), hypnosis (n=6), mental health programmes (n=7), yoga (n=4), cognitive and behavioural interventions (n=1), mind-sound technology (n=1), music-based interventions (n=1), omega-3 supplementation (n=1), electroacupuncture (n=1) and osteopathic manipulative treatment (n=1). The curriculum-level interventions included pass/fail grading (n=4), problem-based curriculum (n=2) and multicomponent curriculum reform (n=2). Most interventions were not supported by sufficient evidence to establish effectiveness. Eleven reviews were rated as having 'critically low' quality, and two reviews were rated as having 'low' quality.

Conclusions Individual-level interventions (mindfulness and mental health programmes) and curriculum-level interventions (pass/fail grading) can improve medical student well-being. These conclusions should be tempered by the low quality of the evidence. Further high-quality research is required to explore additional effective interventions to enhance medical student well-being and the most efficient ways to implement and combine these for maximum benefit.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Two reviewers independently rated the evidence of effectiveness for each intervention and outcome to guide the selection of appropriate interventions and highlight important gaps in the evidence base.
⇒ Primary study overlaps between the included reviews precluded panoramic meta-analysis.
⇒ A comprehensive narrative synthesis summarises the effectiveness of interventions for medical student well-being from 94 independent, non-overlapping primary studies and at least 17 616 medical students.
⇒ The quality of evidence in this space is low, limiting the strength of the conclusions.

INTRODUCTION

Medical schools around the world are expected to support the well-being of their students.[1] Despite this, medical students end up experiencing more mental health problems, such as depression, anxiety and burnout, than their peers.[2 3] Although they begin medical school with better well-being than their peers, medical students' well-being declines throughout their training.[4] This has been attributed to the demanding study load, lengthy contact hours and competitive culture within undergraduate medical education.[2 5–9]

Poor well-being (including burnout and stress) is serious; it is associated with suicidal ideation, poor academic performance and low empathy in medical students.[10–12] Moreover, medical students who have low well-being are likely to have poor well-being as qualified physicians.[13 14] Physician mental ill-health has wide-ranging workforce consequences and is associated with reduced quality of care and increased medical errors.[15–17]

There is no consensus regarding the correct definition of 'well-being'. Well-being has variously been defined as 'a positive state experienced by individuals and societies',[18] as comprising 'an individual's experience of their life and a comparison of life circumstances with social norms and values'[19] and as 'the presence of positive emotions and moods (eg, contentment and happiness),

the absence of negative emotions (eg, depression and anxiety), satisfaction with life, fulfilment and positive functioning'.[20] Despite the differing definitions, there is agreement that, like health, well-being includes psychological, physical and social components.[1 18 20] Following previous research, we take medical student well-being to be any aspect of physical, social or mental and emotional health.[9]

Several reviews have explored the effectiveness of interventions to enhance medical student well-being, suggesting that mindfulness interventions and pass/fail grading may be effective.[5 21 22] However, they have focused on a single intervention,[22–25] a single facet of well-being (such as burnout),[21–28] or on evidence from a single country (often the USA).[21 26] While helpful, medical schools need to have an overview of all of the potential interventions to enhance their students' well-being. There is no up-to-date synthesis of the evidence in this field across all interventions, outcomes and countries. An overview of systematic reviews is therefore warranted to bring this vast and disparate evidence base together and help solve the problem of low medical student well-being.

Objective

To conduct an overview of systematic reviews exploring the effectiveness of interventions to enhance medical student well-being.

METHODS

We undertook an overview of systematic reviews following the Cochrane Handbook for Systematic Reviews of Interventions.[29] The reporting of this overview is guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses.[30] Where necessary, we have made adaptations for an overview of reviews following the Cochrane Handbook.[29] The overview protocol was prospectively registered (PROSPERO: CRD42023429007).

Eligibility criteria

We included systematic reviews[31–33] of interventions to enhance undergraduate medical student well-being. We only included reviews in which the participants were medical students. We included reviews that included other participant groups or outcomes, provided that the results for medical students or well-being were reported separately. As there is no core outcome set[34] for well-being, we followed previous reviews, taking well-being to be synonymous with wellness, physical well-being/health, social well-being/health, mental well-being/health, emotional well-being/health and to be closely related to depression, anxiety, quality of life, stress, burnout, resilience and suicidal ideation.[5 9 21 22] Also following the previous reviews in this area,[5 21] we distinguished between stress (an acute response caused by an external trigger) and anxiety (persistent worries that do not cease even in the absence of a stressor).[35] The eligibility criteria is summarised in table 1.

Search strategy

On 1 June 2023, we searched the Cochrane Library of Systematic Reviews, MEDLINE, APA PsychInfo, CINAHL and Scopus from database inception dates until 31 May 2023. A comprehensive grey literature search was conducted in OpenGrey, along with ancestry searching,[36] and citation chasing for included reviews. A comprehensive search strategy was created by an information specialist (KN). The search strategy for each database can be found in online supplemental appendix 1.

Selection process

Search results were deduplicated, exported into Endnote for manual checks and transferred to Covidence.[37] Screening by title and abstract and screening of the full texts were completed in duplicate by two reviewers (from ABW, LK, MJ, CS and CL). Disagreements were resolved

Table 1 Eligibility criteria

Criteria	Inclusion	Exclusion
Study design	Systematic reviews of randomised controlled trials and non-randomised studies of interventions, including non-randomised trials, observational studies, case-control or other controlled or uncontrolled quasi-experimental studies and cohort studies that reported quantitative outcomes.	Primary research. Non-systematic reviews, for example, non-systematic narrative reviews and literature reviews. Editorials.
Participants	Undergraduate or graduate-entry medical students enrolled on an undergraduate medical education programme.	Postgraduate medical students, non-medical students and qualified healthcare professionals.
Intervention	Any intervention aimed at enhancing medical student well-being.	Any intervention not aimed at enhancing undergraduate medical student well-being.
Comparators	No intervention (education as usual), waitlist control or no control group (pre-test/post-test).	
Outcome(s)	Medical student well-being, including physical, psychological and/or social components.	Reviews that do not include medical student well-being as an outcome.
Setting and language	Any	

in discussion and with a third reviewer (JH) where necessary.

Data collection process

A prepiloted, standardised Microsoft Excel data extraction sheet was used to extract key characteristics of reviews and their primary studies (see online supplemental appendix 2). Data extraction was performed in duplicate by two reviewers (from ABW, LK, MJ, CS and CL). Discrepancies were resolved through discussion.

Review quality appraisal

Quality assessment was performed by two independent reviewers (from ABW, LK, MJ, CS and CL) using the Assessing the Methodological Quality of Systematic Reviews V.2 (AMSTAR-2) tool.[38] Disagreements were resolved in discussion and with a third reviewer (JH) where necessary. The AMSTAR-2 has 16 items, seven of which are categorised as 'critical domains'.[38] The critical domains include whether the protocol was registered before the commencement of the review, the adequacy of the literature search, justification for excluding individual studies, the risk of bias, the appropriateness of meta-analytical methods, consideration of the risk of bias when interpreting the results of the review and an assessment of the presence and likely impact of publication bias. Each item is phrased as a question, where an answer of 'yes' indicates that the item was achieved, a 'no' indicates that the item was not present (this is considered a non-critical or critical weakness depending on the item) and a 'partial yes' indicates that the item was partially achieved.[38] Following AMSTAR-2 guidance, reviews were categorised as having high (no or one non-critical weakness), moderate (more than one non-critical weakness), low (one critical weakness with or without non-critical weaknesses) or critically low (more than one critical weakness with or without non-critical weaknesses) quality.[38] We did not reassess the quality of the individual primary studies included in each review.

Data synthesis

Pooling via panoramic meta-analysis was deemed inappropriate due to considerable primary study overlap across reviews,[29] so we conducted a narrative synthesis.[39] This was organised first by intervention and then by outcome. As we intended to describe the current body of systematic review evidence, we followed Cochrane guidance and synthesised all systematic reviews regardless of primary study overlap.[29]

In a second synthesis step, we used an established methodology to rate the evidence of effectiveness across reviews.[40] First, this involved two reviewers (ABW and MJ) independently assigning standardised 'effectiveness statements' to indicate the sufficiency of the evidence of effectiveness for each intervention and outcome (see online supplemental table 1, adapted from Ryan *et al*[40]). Effectiveness statements were 'sufficient evidence' (strong evidence to make a decision about the effect of the intervention for a specific outcome), 'some evidence' (less conclusive evidence to make a decision about the effect of an intervention), 'generally ineffective' (considerable evidence of no effect) and 'insufficient evidence' (not enough evidence to determine intervention effectiveness). Second, we used vote counting to rate the evidence of effectiveness (summing and comparing the number of primary studies showing a statistically significant benefit of an intervention, those showing no effect and those showing harm). When assigning a rating, we also considered the number of participants included in the studies for each intervention and outcome.[40] To address primary study overlap, we based ratings of the evidence of effectiveness for each intervention and outcome on independent primary studies and their participants. Discrepancies were resolved through discussion with a third reviewer (JH) where necessary.

Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

RESULTS

Our searches generated 2278 records after duplicates were removed. 2181 records were excluded at the title and abstract screening stages and full texts of 91 records were sought for full-text screening. 78 records were excluded at the full-text screening stage. Articles were excluded due to ineligible participants (n=25), ineligible study design (n=21), ineligible or no reported intervention (n=18) and ineligible outcomes (n=14). A full list of excluded studies with reasons is provided in online supplemental table 2. A final sample of 13 reviews was included in this overview.[5 9 21 24 26–28 41–46] The review identification and selection processes are represented in figure 1.

Description of the included reviews

The characteristics of the included systematic reviews are described in table 2. All reviews were published between 2008 and 2023 and were from the USA,[9 21 28 43] Brazil,[24] Canada,[26 45] Australia,[5] Indonesia,[42] the UK,[27] Italy,[41] France[46] and Malaysia.[44] The reviews comprised 202 primary studies of interventions to enhance medical student well-being and included at least 37 685 medical students (three reviews included primary studies in which sample sizes were not reported). Of these studies, there were 94 non-overlapping, independent primary studies, which included at least 17 616 medical students. The descriptions of participants' demographic information were limited. Two reviews included only randomised controlled trials (RCTs)[24 45]; 11 reviews included a mix of RCTs and non-randomised studies.[5 9 21 26–28 41–44 46]

The reviews covered both individual-level and curriculum-level interventions. Individual interventions included mindfulness (n=12), hypnosis

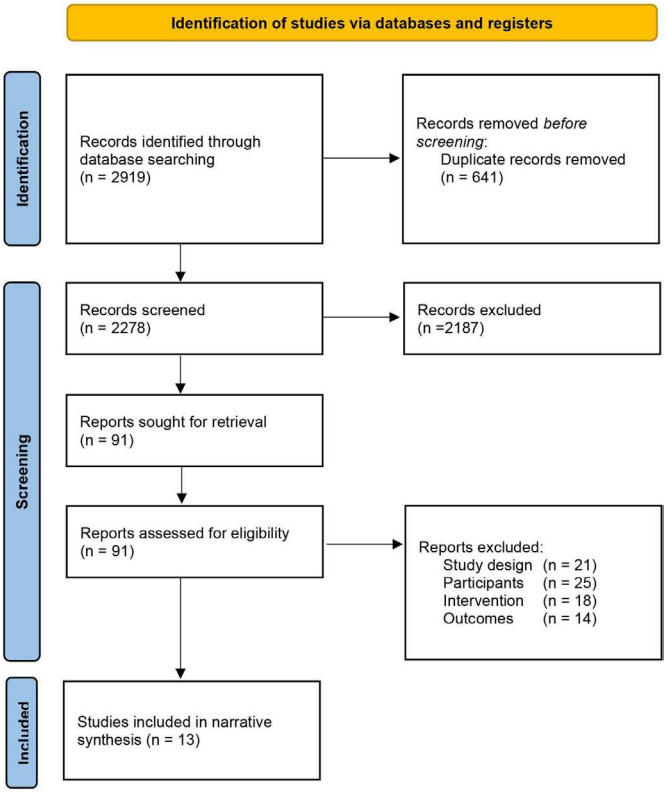

Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram.

(n=6), mental health programmes (education on stress management, self-care and accessing mental health services)[21] (n=7), yoga (n=4), cognitive and behavioural interventions (n=1), mind-sound technology (n=1), music-based interventions (n=1), omega-3 supplementation (n=1), electroacupuncture (n=1) and osteopathic manipulative treatment (n=1). The curriculum-level interventions included pass/fail grading (n=4), problem-based curricular structure (n=2) and multicomponent curriculum reform (reforming multiple components of the curriculum simultaneously) (n=2). A description of each intervention is provided in the narrative synthesis below.

Twelve reviews[5 9 21 24 26–28 41–45] included primary studies that measured well-being outcomes using a mix of validated and non-validated scales. For example, stress was often measured using the Perceived Stress Scale[47] (a validated scale), but it was also measured using non-validated scales developed by the authors of primary studies included in the reviews (eg, a scale to ascertain students' self-reported awareness of stress).[48] Only one review[46] included studies that exclusively used validated outcome measures.

Quality of included reviews

Eleven reviews[5 9 24 26–28 41 43–46] were rated as having 'critically low' quality according to AMSTAR-2, and two reviews[21 42] were rated as having 'low' quality. Most reviews (n=12)[5 9 21 24 26–28 41–45] did not provide a list of excluded studies with reasons for exclusion, and several (n=5)[9 28 44–46] did not report duplicate screening and/or data extraction. The quality assessments for each included review are summarised in online supplemental table 3. Reviews[5 21 24 27 28 41 43] that reported quality appraisal of their included primary studies described quality as moderate to low or risk of bias as moderate to high.

Effects of interventions

The narrative synthesis below is organised as follows: first, we present the results for individual-level interventions (mindfulness, hypnosis, mental health programmes, yoga, cognitive and behavioural interventions, mind-sound technology, omega-3 supplementation, music-based interventions, electroacupuncture and osteopathic manipulative treatment). Next, we present the results for curriculum-level interventions (pass/fail grading, problem-based curriculum and multicomponent curriculum reform). Within each intervention type, we present the results by outcome.

Individual-level interventions

Mindfulness

Twelve reviews[5 21 24 26–28 41–46] considered the effects of mindfulness interventions on well-being, stress, anxiety, depression, burnout and resilience. Mindfulness interventions were primarily based on Jon Zabat-Kinn's[49] work, seeking to bring attention to current experience through (often guided) meditation. The intervention duration varied between 4 and 22 weeks. The effects of mindfulness were mixed. None of the included reviews reported the effects of intervention duration on any of the reported outcomes.

One review[24] found no statistically significant effect of mindfulness on well-being postintervention in a meta-analysis of four studies, three of which were RCTs (standardised mean difference (SMD)=−0.27; 95% CI −0.67 to 0.13; p=0.18; I^2=76%).

Ten reviews[21 24 26–28 41 43–46] included studies of mindfulness for reducing stress. Six reviews[24 26 28 41 43 45] found a benefit of mindfulness for reducing stress. Two of these included a meta-analysis: one review[24] found a small and statistically significant effect of mindfulness on stress postintervention in their meta-analysis of five studies, four of which were RCTs (SMD=−0.29; 95% CI −0.56 to −0.02; p=0.04; I^2=57%). Another review[45] found a statistically significant reduction in stress postintervention, based on four RCTs (SMD=−0.55; 95% CI −0.74 to −0.36; p≤0.0001; I^2=0%). Four reviews that did not include a meta-analysis[26 28 41 43] concluded that mindfulness reduced stress. Three reviews[27 44 46] concluded that the effects of mindfulness on stress were mixed. One review[21] identified two studies demonstrating no statistically significant effect of mindfulness on stress.

Eight reviews[5 21 24 27 28 41 42 44] included studies of mindfulness for reducing anxiety. Four of these reviews[21 27 28 41] found a benefit of mindfulness for reducing anxiety. Two reviews[42 44] included studies with mixed findings (some showing a benefit of mindfulness for anxiety and some

Table 2 Characteristics of included studies

Author	Year	Geographical location of first author	Review aim/question	Number of included studies	Design(s) of included studies	Total number of participants	Intervention(s)	Outcome(s)
Buizza *et al*[41]	2022	Italy	To identify all studies for stress-management carried out in medical students, in order to analyse their impact on psychological distress and on academic performance, and to assess how these interventions are incorporated into the medical education curriculum.	17	RCT, non-randomised studies	1313	Mindfulness, mental health programmes, hypnosis and mind-sound technology	Stress
Da Silva *et al*[24]	2023	Brazil	To seek evidence regarding the effectiveness of mindfulness-based training programmes in reducing psychological distress and promoting the well-being of medical students.	8	RCT	694	Mindfulness	Psychological distress and well-being
Daya and Hearn[27]	2018	UK	Are mindfulness-based interventions effective for preventing and/or reducing depression, stress, burnout and fatigue in medical students?	12	RCT, non-randomised studies	1197	Mindfulness	Depression, stress, burnout and fatigue
Frajerman[46]	2020	France	To encompass all types of interventions to improve student well-being using scales already validated in the scientific literature up to 2018.	36	RCT, non-randomised studies	6979	Mindfulness, hypnosis, mental health programmes, yoga, music-based, electroacupuncture, osteopathic manipulative treatment, pass/fail grading and problem-based curriculum	Well-being and psychological distress
Kusumadewi *et al*[42]	2021	Indonesia	To identify studies for psychotherapy interventions in medical students to analyse each impact on anxiety level in medical students.	23	RCT, non-randomised studies	2539	Mindfulness, mental health programmes, cognitive and behavioural interventions and hypnosis	Anxiety
McCray *et al*[43]	2008	USA	To review studies on interventions related to burnout other than those that studies work hours limitations.	9 (3 on medical students)	RCT, non-randomised studies	349 (medical students)	Mindfulness and mental health programmes	Burnout
Regehr *et al*[45]	2014	Canada	This analysis included studies evaluating intervention programmes aimed at reducing stress in physicians and medical trainees.	12 (4 on medical students)	RCT, non-randomised studies	462 (medical students)	Mindfulness	Stress

Continued

Table 2 Continued

Author	Year	Geographical location of first author	Review aim/question	Number of included studies	Design(s) of included studies	Total number of participants	Intervention(s)	Outcome(s)
Shiralkar *et al*[28]	2013	USA	To describe how stress-management programmes were incorporated into the medical education curriculum for medical students and their impact on psychological distress.	13	RCT, non-randomised studies	3011	Hypnosis, mindfulness and pass/fail grading	Stress, depression, anxiety and burnout
Spring *et al*[9]	2011	USA	To review all available literature with regard to pass/fail grading in medical education.	13 (4 on well-being)	Non-randomised studies	3958	Pass/fail grading	Well-being
Wasson *et al*[21]	2016	USA	What undergraduate medical education learning environment interventions are associated with improved emotional well-being among medical students?	28	RCT, non-randomised studies	8224	Mindfulness, mental health programmes, hypnosis and multicomponent curriculum reform	Emotional well-being
Witt *et al*[5]	2019	Australia	To conduct a systematic review and meta-analysis of universal interventions aimed at addressing mental ill health, suicidal ideation and behaviour in medical students.	39	RCT, non-randomised studies	7387	Mindfulness, mental health programmes, yoga, omega-3 supplementation and problem-based curricular structure	Suicidal ideation, depression, anxiety, stress and burnout
Yogeswaran and El Morr[26]	2021	Canada	To investigate whether online mindfulness interventions can be used to promote mental health for medical students.	2	Non-randomised studies	99	Mindfulness (online)	Mental health
Yusoff[44]	2014	Malaysia	To what extent are stress management interventions for training medical students associated with improved psychological outcomes in comparison to no intervention?	13	RCT, non-randomised studies	1428	Mindfulness, self-hypnosis and mental health programmes	General psychological distress, stress, anxiety and depression

RCT, randomised controlled trial.

showing no statistically significant effect). Moreover, two reviews[5 24] concluded that there is no effect of mindfulness on anxiety. One of these reviews[5] included a meta-analysis of five RCTs, which demonstrated no significant effect of mindfulness on postintervention anxiety scores (SMD=−0.62, 95% CI −1.63 to 0.38; p=0.22; I^2: 97%).

Of the six reviews[5 24 27 28 44 46] that explored the effects of mindfulness on depression, two identified studies demonstrating a benefit.[28 46] On the other hand, two reviews[27 44] included studies with ambiguous results (some showing a benefit and some showing no effect). Finally, two reviews[5 24] concluded that mindfulness has no effect on depression. One of these reviews[5] included a meta-analysis of six RCTs, which found no statistically significant effect of mindfulness on depression (SMD=−0.52, 95% CI −1.18 to 0.13; p=0.12; I^2: 93%).

Limited evidence has documented the effects of mindfulness on burnout. Three reviews considered mindfulness and burnout.[26 27 46] One review[26] included studies with mixed findings on the effects of mindfulness on burnout (one demonstrating a benefit and two showing no effect). Two others concluded that there was no significant effect of mindfulness on burnout.

One review identified one study showing no effect of mindfulness on resilience.[24]

Hypnosis

Six reviews[21 28 41 42 44 46] reported on the effects of hypnosis on anxiety. Hypnosis interventions typically included clinical hypnosis delivered by an accredited hypnotherapist and self-hypnosis following training by a psychiatrist. Intervention duration varied between a single 1-hour session and 8–10 weeks of once-a-week hourly sessions. All six reviews[21 28 41 42 44] explored the effects of hypnosis on anxiety, identifying studies with equivocal results (some showing a benefit and some showing no effect). None of the included reviews reported the effects of intervention duration on anxiety.

Mental health programmes

Seven reviews[5 21 41–44 46] considered the effectiveness of mental health programmes for stress, anxiety, depression and suicidal ideation. Mental health programmes involve education around stress management, self-care and accessing mental health services.[21] The intervention duration ranged from 2 days to 8 weeks. None of the included reviews reported the effects of intervention duration on any of the reported outcomes.

Four reviews[5 43 44 46] included studies of mental health programmes for reducing stress. One review[44] reported mixed findings on the effect of mental health programmes on stress (some showing a benefit and some showing no effect). The remaining three reviews[5 43 46] concluded that there was no effect of mental health programmes on stress.

Of the four reviews[5 41 42 44] that explored the effects of mental health programmes on anxiety, two[41 42] concluded that there was a benefit. Conversely, another[44] included studies with ambiguous results (some primary studies showing a benefit, some showing no effect and one showing a harmful effect). Yet another review[5] conducted a meta-analysis of three non-randomised studies, finding no statistically significant reduction in anxiety following mental health programmes (SMD=−0.17, 95% CI −0.37 to 0.04; p=0.11; I^2: 0%).

Four reviews included studies of mental health programmes for depression.[5 21 43 46] Two of these found the benefit of mental health programmes for reducing depression.[5 21] Another[46] found studies with mixed findings (some showing a benefit and some showing no effect). The fourth review[43] identified two studies in which there was no statistically significant effect of mental health programmes on depression.

Limited evidence has reported the effects of mental health programmes on suicidal ideation. Three reviews[5 21 46] included the same primary study demonstrating a significant reduction in suicidal ideation following a mental health programme aimed at reducing mental health stigma and providing education about mental health services.[50]

Yoga

Four reviews[5 41 42 46] explored the effects of yoga on well-being, stress, anxiety and depression. Interventions were based on Hatha yoga,[51] consisting of *asanas* (postures and stretches), *pranayama* (breathing exercises) and meditation. Interventions lasted between 6 and 16 weeks. One review found a benefit of yoga for medical students' mental well-being and for reducing their anxiety.[42] Two reviews[41 46] identified studies in which there was no statistically significant effect on stress. Finally, two reviews[5 46] included the same primary study in which there was no statistically significant effect of yoga on depression.[52]

Cognitive and behavioural interventions

One review[42] included studies of the effects of cognitive and behavioural interventions. These interventions included elements of positive psychology (interventions that seek to cultivate positive feelings, thoughts and behaviours)[53] and cognitive behavioural therapy (a talking therapy in which negative patterns of thought and behaviour are identified and challenged).[54] The intervention duration varied from a single session to a series of sessions lasting between 10 and 16 weeks. One review[42] identified studies with mixed findings regarding the effect of cognitive and behavioural interventions on both anxiety and depression.

Mind-sound technology

One review[41] included a single study[55] demonstrating the benefit of mind-sound technology for reducing anxiety and depression. In this 6-week intervention, participants introduce sounds into various parts of the body with their own voice, stimulating different parts of the brain.

Table 3 Evidence of effectiveness for interventions by outcome

Intervention	Outcome	Review(s)	No. of studies across review(s)*	No. of studies showing benefit*	No. of studies showing no effect*	No. of studies showing harm*	No. of students	Evidence of effectiveness
Individual-level interventions								
Mindfulness	Well-being	1	4	1	3	0	453	Insufficient evidence
	Stress	10	18	13	4	1	1789	Some evidence of benefit
	Anxiety	8	8	5	3	0	1294	Some evidence of benefit
	Depression	6	12	8	4	0	1625	Some evidence of benefit
	Burnout	3	4	1	3	0	404	Insufficient evidence
	Resilience	1	1	0	1	0	57	Insufficient evidence
Hypnosis	Anxiety	6	2	1	1	0	71	Insufficient evidence
Mental health programmes	Stress	4	6	2	4	0	849	Generally ineffective
	Anxiety	4	11	7	3	1	1947	Some evidence of benefit
	Depression	4	6	4	2	0	2687	Some evidence of benefit
	Suicidal ideation	3	1	1	0	0	188	Insufficient evidence
Yoga	Well-being	1	1	1	0	0	90	Insufficient evidence
	Stress	2	2	2	0	0	50	Insufficient evidence
	Anxiety	1	2	2	0	0	82	Insufficient evidence
	Depression	2	1	0	1	0	16	Insufficient evidence
Cognitive and behavioural	Anxiety	1	2	1	1	0	101	Insufficient evidence
	Depression	1	3	2	1	0	163	Insufficient evidence
Mind-sound technology	Anxiety	1	1	1	0	0	42	Insufficient evidence
	Depression	1	1	1	0	0	42	Insufficient evidence
Omega-3 supplementation	Anxiety	1	1	1	0	0	68	Insufficient evidence
	Depression	1	1	0	1	0	68	Insufficient evidence
Music-based interventions	Stress	1	1	1	0	0	90	Insufficient evidence
	Anxiety	1	1	1	0	0	90	Insufficient evidence
	Burnout	1	1	0	1	0	90	Insufficient evidence
Electroacupuncture	Anxiety	1	1	1	0	0	25	Insufficient evidence
	Depression	1	1	1	0	0	25	Insufficient evidence
	Burnout	1	1	1	0	0	25	Insufficient evidence
Osteopathic manipulative treatment	Stress	1	1	0	1	0	30	Insufficient evidence

Continued

Table 3 Continued

Intervention	Outcome	Review(s)	No. of studies across review(s)*	No. of studies showing benefit*	No. of studies showing no effect*	No. of studies showing harm*	No. of students	Evidence of effectiveness
Curriculum-level interventions								
Pass/fail grading	Stress	4	3	3	0	0	1554	Some evidence of benefit
	Anxiety	4	2	2	0	0	362	Insufficient evidence
	Depression	4	2	2	0	0	362	Insufficient evidence
	Burnout	2	1	1	0	0	1192	Insufficient evidence
Problem-based curriculum	Anxiety	2	1	0	1	0	637	Insufficient evidence
	Depression	2	2	0	2	0	982	Insufficient evidence
Multicomponent curriculum reform	Well-being	1	1	1	0	0	478	Insufficient evidence
	Stress	2	1	1	0	0	875	Insufficient evidence
	Anxiety	2	1	1	0	0	875	Insufficient evidence
	Depression	2	1	1	0	0	875	Insufficient evidence

*Figures reflect independent, non-overlapping primary studies and their participants.

Music-based interventions

One review[46] identified one study[56] that showed a statistically significant reduction in stress and anxiety following a music-based intervention. There was no statistically significant effect of the intervention on burnout. The intervention comprised a single session lasting 20 min in which participants listened to light instrumental music.[56]

Omega-3 supplementation

One review[5] included a single study[57] in which omega-3 fatty acid supplementation had a modest treatment effect on anxiety, but not depression. The frequency and duration of supplementation were not reported.

Electroacupuncture

One review[46] included one study showing the benefit of electroacupuncture (needles are placed in the body and a small amount of electricity is passed through them via an electrode) for reducing medical student stress.[58] The intervention consisted of a 20-min session, once a week, for 6–8 weeks.

Osteopathic manipulative treatment

One review[46] included a study exploring the effectiveness of osteopathic manipulative treatment, whereby light pressure is applied to muscles and soft tissues in which stress is known to manifest.[59] The intervention comprised one 20-min session per week, for 4 weeks. The result showed no statistically significant effect on stress.

Curriculum-level interventions

Pass/fail grading system

Four reviews[9 21 28 46] explored the effects of changing traditional medical school tiered grading systems to pass/fail grading systems on stress, anxiety, depression and burnout. Pass/fail grading was implemented in the first year of medical school, or both the first and second years. All four reviews[9 21 28 46] found the benefit of implementing a pass/fail grading system for reducing stress, anxiety and depression. Two reviews[21 28] identified the same primary study which showed a statistically significant effect of pass/fail grading systems for reducing medical student burnout.

Problem-based curriculum

Two reviews[5 46] included studies exploring the effects of changing the curriculum from a didactic, lecture-based structure to a problem-based structure on anxiety and depression. A problem-based learning curriculum emphasises self-directed learning within small-group, problem-solving sessions.[60] Both reviews[5 46] concluded that there was no statistically significant effect of implementing a problem-based curriculum on anxiety or depression.

Multicomponent curriculum reform

Two reviews[21 46] included studies of the effects of reforming multiple components of the curriculum simultaneously. This involved concurrently implementing a number of interventions, including pass/fail grading,

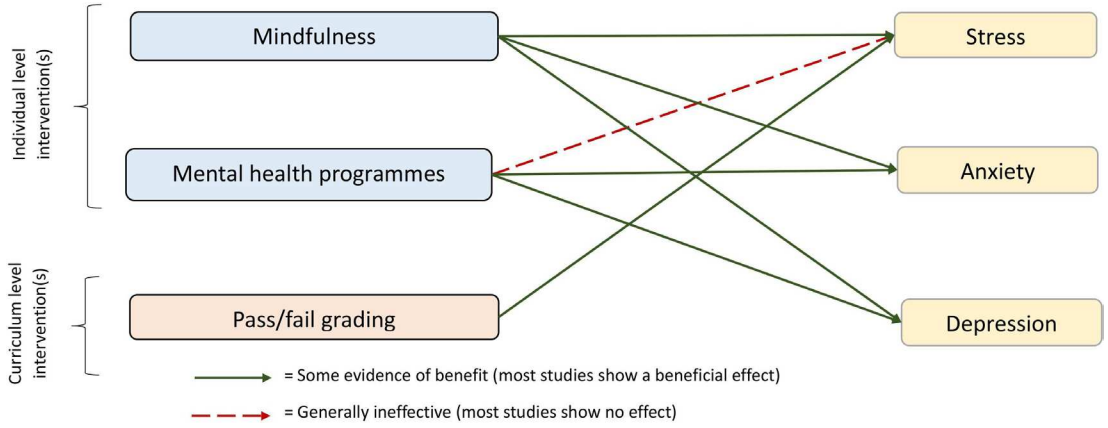

Figure 2 Interventions showing some evidence of benefit and general ineffectiveness.

reduced preclinical contact hours and mindfulness.[21] One review[21] found that multicomponent curriculum reform improved mental and social well-being. Both reviews included studies showing benefits for reducing stress, anxiety and depression.

Evidence of effectiveness

Following narrative synthesis, we rated the evidence of the effectiveness of each intervention by the outcome, adopting established methodologies from previous Cochrane overviews[40] (see online supplemental file 1). The rating of evidence of effectiveness for each intervention and outcome is summarised in table 3.

There was 'some evidence' of the benefit of mindfulness for reducing stress, anxiety and depression, of pass/fail grading for reducing stress and of mental health programmes for reducing anxiety and depression. However, mental health programmes appeared to be 'generally ineffective' for reducing stress. For most interventions, there was 'insufficient evidence' to determine effectiveness. In particular, there were a number of novel interventions for which there was evidence from only one primary study: mind-sound technology, omega-3 supplementation, electroacupuncture and osteopathic manipulative treatment. The interventions that show some evidence of a benefit and those that are generally ineffective for medical student well-being are summarised in figure 2.

DISCUSSION

Summary of findings

This overview of 13 systematic reviews found that mindfulness, mental health programmes and pass/fail grading systems can improve medical student well-being. Evidence was inconclusive for the effectiveness of hypnosis, yoga, cognitive and behavioural interventions, omega-3 supplementation, mind-sound technology, music-based interventions, electroacupuncture, osteopathic manipulative treatment, implementing a problem-based curriculum and multicomponent curriculum reform.

Relationship to other evidence

There is overwhelming evidence for mindfulness for medical student well-being.[5 21 24 26–28 41–46] By taking a broad approach, this overview of reviews has identified a vaster range of interventions than previous reviews.[5 21] These include hypnosis, yoga and cognitive and behavioural interventions, for which limited evidence is beginning to show promising effects on medical student well-being.[5 21 28 41 42 44 46]

In line with previous research, this overview indicates that the evidence for the effects of interventions to enhance medical student well-being is inconsistent.[5 24 27 41 61] Previous reviews have found that mindfulness is effective for reducing medical student stress[5 21 24] but not anxiety or depression.[5 24 27] Our findings confirm that mindfulness is beneficial for reducing stress and add that there is some evidence of the benefit of mindfulness for reducing anxiety and depression. The mixed findings regarding mindfulness may be attributable to the great variation in the way mindfulness is taught and the context in which it is delivered (and consequently received).[62]

Mental health programmes have previously been recommended to improve medical student well-being.[21] Our findings indicate that while mental health programmes can reduce medical student anxiety and depression, they are generally ineffective for reducing stress. This finding is surprising given that many of the programmes focused on educating students about stress-management techniques.[44] It could be explained by the focus of mental health programmes on the individual experience of stress, which precludes consideration of the environmental factors that contribute to medical student stress in the first place.[2 5–9]

Previous research on curriculum-level interventions found that pass/fail grading is effective for improving medical student well-being.[9 21] We confirmed that pass/fail grading can reduce stress but found that there was insufficient evidence of the benefits of pass/fail grading for reducing anxiety. However, the limited evidence that does exist for the effects of pass/fail grading on anxiety is tentatively positive.[63 64] These promising findings may

be explained by the decrease in within-cohort competition and increase in cohort cohesion that accompany the implementation of a pass/fail grading system.[65] Our research also broadly corroborates previous findings that physician well-being is best enhanced by combining individual-level and organisational-level interventions.[66 67] One review[21] included limited yet promising evidence regarding the effects of multicomponent curricular reform on medical student well-being.

Strengths and limitations

This is the first overview of reviews of interventions to enhance medical student well-being. The findings synthesise a vast amount of evidence from 13 systematic reviews, 94 independent primary studies and at least 17 616 medical students. In contrast, the largest included review[5] included only 39 primary studies and 7387 medical students. By rating the evidence of effectiveness for each intervention and outcome, our findings provide a map to guide the selection of appropriate interventions and highlight important gaps in the evidence base.

This overview also has a number of limitations. There was considerable primary study overlap, which precluded a panoramic meta-analysis. We addressed the potential bias introduced by such overlap[29] by basing our rating of the evidence of effectiveness only on non-overlapping, independent primary studies. Furthermore, the quality of the primary studies within our included reviews was described as low,[5 21 24 27 28 41 43] and all reviews were rated as 'low' or 'critically low' using the AMSTAR-2 tool.[38] Our analysis is also limited by the details of the reporting of interventions and their contexts. The heterogeneity of effects of mindfulness, for example, could be explained with additional data about the qualifications of the mindfulness teachers, the length of sessions, students' baseline well-being scores, etc. An intervention would appear less effective overall if delivered to students with moderate well-being as well as to those with poor well-being.

Finally, all reviews focused almost exclusively on psychological well-being. We know, however, that well-being has psychological, physical and social components.[1 18 20 68] In addition, all reviews focused heavily on the absence of well-being (measuring outcomes like stress, anxiety and depression). Yet, definitions of well-being emphasise both the absence of negative emotions and the presence of positive ones.[18 20] Linked to this, as there is no core outcome set[34] for well-being, it is possible that we might have missed additional relevant reviews exploring different outcomes that could be classed as well-being.

Implications for further research

This overview of reviews has highlighted a number of avenues for further research:

- Determining a core outcome set[34] for medical student well-being.
- Conducting a large-scale review and meta-analysis of primary studies using the interventions and outcomes identified in this overview. This meta-analysis should include an analysis of the effective components and contexts for maximising the benefits of interventions (eg, using component network meta-analysis).[29]
- Conducting a review of qualitative research on interventions to enhance medical student well-being to further clarify the effective components and contexts of successful interventions.
- Designing and delivering high-quality studies, such as randomised trials, to test the benefits of all interventions.
- Exploring additional interventions that are more effective at enhancing psychological well-being, along with interventions that enhance other facets of well-being (physical and social).
- This should include an exploration of the effects of interventions on both positive (such as resilience, quality of life and fulfilment) and negative (such as anxiety, depression and stress) markers of well-being.
- Exploring the longer-term consequences of some of the interventions. While it is unlikely that mental health or mindfulness programmes will have unanticipated negative consequences,[5] the repercussions of pass/fail grading systems on academic performance, preparedness for practice and well-being could either be unwanted[63] or beneficial.[9 21]

CONCLUSIONS

Mindfulness, mental health programmes and pass/fail grading may improve medical student well-being. The quality of evidence in this space is, overall, low. Given its importance for medical students, future doctors and patients, further rigorous research is needed to identify additional interventions to enhance medical student well-being, the most effective ways to implement interventions, and how to combine the interventions for maximum benefit.

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Contributors JH and ABW were involved in the conceptualisation of this research. KN developed the search strategy. ABW, LK, CS, MJ and CL screened titles and abstracts and full texts and completed data extraction and quality assessment. JH acted as a third senior reviewer to resolve discrepancies. ABW drafted the manuscript and JH and JS further developed it. All authors made substantial contributions to revisions of the manuscript. All authors read and approved the final manuscript. ABW is the guarantor.

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Interventions to promote medical student wellbeing: An overview of systematic reviews

Supplemental material

Supplemental Appendix 1: Search strategies for all databases

Ovid MEDLINE

1. Students, Medical/
2. education, medical, undergraduate/
3. ((student* or undergraduate*) adj3 (medical or medicine)).mp.
4. exp Emotions/
5. personal satisfaction/
6. Health.mp.
7. (feel* or emotion* or affect or mood* or anxiet* or anxious* or fear* or frustrat* or happi* or happy or sad or lonely or loneli* or please* or pleasure or hate* or anger* or guilt* or shame* or hope* or hostil* or jealous* or satisf*).mp. 2153049
8. Mental health/
9. exp Mental disorders/
10. cultur*.mp.
11. (burnout or stress* or wellness or well-being or wellbeing or depress*).mp.
12. abus* or mistreat* or harass* or hostil* or punish* or professional* or unprofessional* or support* or unsupport* or humiliat* or disparag* or ignor* or unsafe or safe* or harm* or personal service or appropriat* or inappropriat* or respect* or disrespect*).mp.
13. empathy/
14. (empath* or compassion or collegial* or resilien* or cooperat* or collaborat* or kind* or integrity or self-esteem or self esteem).mp.
15. ("quality of life" or QoL).mp.
16. exp "Quality of Life"/
17. Distress*.mp.
18. suicid* ideation.mp. or Suicidal ideation/
19. exp prejudice/
20. (discriminat* or sexism or sexist or sexual or racis* or race or ethnic* or bias*).mp.
21. or/1-3
22. or/4-20
23. 21 and 22
24. Meta-Analysis as Topic/
25. meta analy$.tw.
26. metaanaly$.tw.
27. Meta-Analysis/
28. (systematic adj (review$1 or overview$1)).tw.
29. exp Review Literature as Topic/
30. or/24-29
31. cochrane.ab.
32. embase.ab.
33. (psychlit or psyclit).ab.
34. (psychinfo or psycinfo).ab.
35. (cinahl or cinhal).ab.
36. science citation index.ab.
37. bids.ab.
38. cancerlit.ab.
39. or/31-38
40. reference list$.ab.

41. bibliograph$.ab.
42. hand-search$.ab.
43. relevant journals.ab.
44. manual search$.ab.
45. or/40-44
46. selection criteria.ab.
47. data extraction.ab.
48. 46 or 47
49. Review/
50. 48 and 49
51. Comment/
52. Letter/
53. Editorial/
54. animal/
55. human/
56. 54 not (54 and 55)
57. or/51-53,56
58. 30 or 39 or 45 or 50
59. 58 not 57
60. 23 and 59

Cochrane Library

1. MeSH descriptor: [Students, Medical] explode all trees
2. MeSH descriptor: [Education, Medical, Undergraduate] explode all trees
3. ((student* OR undergraduate*) NEXT/2 (medical or medicine)):ti,ab,kw
4. MeSH descriptor: [Emotions] explode all trees
5. MeSH descriptor: [Personal Satisfaction] explode all trees
6. Health:ti,ab,kw
7. (feel* OR emotion* OR affect OR mood* OR anxiet* OR anxious* OR fear* OR frustrat* OR happi* OR happy OR sad OR lonely OR loneli* OR please* OR pleasure OR hate* OR anger* OR guilt* OR shame* OR hope* OR hostil* OR jealous* OR satisf*):ti,ab,kw
8. MeSH descriptor: [Mental Health] explode all trees
9. MeSH descriptor: [Mental Disorders] explode all trees
10. cultur*:ti,ab,kw
11. (burnout or stress* or wellness or well-being or wellbeing or depress*):ti,ab,kw
12. (abus* or mistreat* or harass* or hostil* or punish* or professional* or unprofessional* or support* or unsupport* or humiliat* or disparag* or ignor* or unsafe or safe* or harm* or personal service or appropriat* or inappropriat* or respect* or disrespect*):ti,ab,kw
13. MeSH descriptor: [Empathy] explode all trees
14. (empath* or compassion or collegial* or resilien* or cooperat* or collaborat* or kind* or integrity or self-esteem or self esteem):ti,ab,kw
15. ("quality of life" or QoL):ti,ab,kw
16. MeSH descriptor: [Quality of Life] explode all trees
17. Distress*:ti,ab,kw
18. "suicid* ideation":ti,ab,kw
19. MeSH descriptor: [Suicidal Ideation] explode all trees
20. MeSH descriptor: [Prejudice] explode all trees
21. (discriminat* OR sexism OR sexist OR sexual OR racis* OR race OR ethnic* OR bias*):ti,ab,kw
22. {OR #1-#3}

23. {OR #4-#21}
24. ##22 AND #23

CINAHL

S1. (MH "Students, Medical")

S2. (MH "Education, Medical")

S3. ((student* or undergraduate*) N2 (medical or medicine))

S4. (MH "Emotions+")

S5. (MH "Personal Satisfaction+")

S6. Health

S7. (feel* or emotion* or affect or mood* or anxiet* or anxious* or fear* or frustrat* or happi* or happy or sad or lonely or loneli* or please* or pleasure or hate* or anger* or guilt* or shame* or hope* or hostil* or jealous* or satisf*)

S8. (MH "Mental Health")

S9. (MH "Mental Disorders+")

S10. cultur*

S11. (burnout or stress* or wellness or well-being or wellbeing or depress*)

S12. (abus* or mistreat* or harass* or hostil* or punish* or professional* or unprofessional* or support* or unsupport* or humiliat* or disparag* or ignor* or unsafe or safe* or harm* or personal service or appropriat* or inappropriat* or respect* or disrespect*)

S13. (MH "Empathy")

S14. (empath* or compassion or collegial* or resilien* or cooperat* or collaborat* or kind* or integrity or self-esteem or self esteem)

S15. ("quality of life" or QoL)

S16. (MH "Quality of Life+")

S17. Distress*

S18. suicid* ideation

S19. (MH "Suicidal Ideation")

S20. (MH "Prejudice+")

S21. (discriminat* or sexism or sexist or sexual or racis* or race or ethnic* or bias*)

S22. S1 OR S2 OR S3

S23. S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21

S24. S22 AND S23

S25. (MH "Meta Analysis")

S26. Meta Analys*

S27. Metaanalys*

S28. (MH "Literature Review+")

S29. (systematic N1 (review or overview))

S30. S25 OR S26 OR S27 OR S28 OR S29

S31. PT commentary

S32. PT letter

S33. PT Editorial

S34. (MH "Animals+")

S35. S31 OR S32 OR S33 OR S34

S36. S30 NOT S35

S37. S24 AND S36

APA PsychInfo

S1. (DE "Students, Medical")

S2. (DE "Education, Medical")

S3. ((student* or undergraduate*) N2 (medical or medicine))

S4. (DE "Emotions+")

S5. (DE "Satisfaction+")

S6. Health

S7. (feel* or emotion* or affect or mood* or anxiet* or anxious* or fear* or frustrat* or happi* or happy or sad or lonely or loneli* or please* or pleasure or hate* or anger* or guilt* or shame* or hope* or hostil* or jealous* or satisf*)

S8. (DE "Mental Health+")

S9. (DE "Mental Disorders+")

S10. cultur*

S11. (burnout or stress* or wellness or well-being or wellbeing or depress*)

S12. (abus* or mistreat* or harass* or hostil* or punish* or professional* or unprofessional* or support* or unsupport* or humiliat* or disparag* or ignor* or unsafe or safe* or harm* or personal service or appropriat* or inappropriat* or respect* or disrespect*)

S13. (DE "Empathy")

S14. (empath* or compassion or collegial* or resilien* or cooperat* or collaborat* or kind* or integrity or self-esteem or self esteem)

S15. ("quality of life" or QoL)

S16. (DE "Quality of Life+")

S17. Distress*

S18. suicid* ideation

S19. (DE "Suicidal Ideation")

S20. (DE "Prejudice+")

S21. (discriminat* or sexism or sexist or sexual or racis* or race or ethnic* or bias*)

S22. S1 OR S2 OR S3

S23. S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21

S24. S22 AND S23

S25. (DE "Meta Analysis")

S26. Meta Analys*

S27. Metaanalys*

S28. (DE "Literature Review+")

S29. (systematic N1 (review or overview))

S30. S25 OR S26 OR S27 OR S28 OR S29

S31. PZ Comment/Reply

S32. PZ letter

S33. PZ Editorial

S34. (DE "Animals+")

S35. S31 OR S32 OR S33 OR S34

S36. S30 NOT S35

S37. S24 AND S36

Supplemental Appendix 2: Data items

The following data was extracted from included reviews:

- Administrative information: review ID, ID of person extracting data, reference citation, review author contact details, publication type.
- General demographics: first author, date published, study country.
- Review eligibility: type of study, participants, type of intervention, type of comparator, outcome measure(s).
- Characteristics of included reviews: aim(s), design (including design(s) of included studies) eligibility criteria, start date, end date, number of studies included, method of synthesis (meta-analysis or narrative or both).
- Participants: number of participants included in the review, description of participant demographics.
- Interventions: description of the types of interventions included, including setting, duration.
- Comparator: description of the control group.
- Outcomes: Outcomes: the value of the main measure(s) of medical student wellbeing will be extracted for each review, together with effect estimates, 95% confidence intervals, P values, and measures of heterogeneity. Outcomes from subgroup analyses will be extracted. Narratively reported outcome data will also be extracted. We will make a free-text list of all available outcomes reported in the review, in addition to those we specifically target.
- Risk of bias/methodological quality of included primary studies.

Supplemental Table 1. Statements for rating the evidence of effectiveness

The following eTable was reproduced from Ryan et al.[1]

Effectiveness statement	Translation
Sufficient evidence	Evidence to make a decision about the effect of the intervention(s) in relation to specific outcome(s). This includes evidence of an effect in terms of (i) benefit or (ii) harm. Statistically significant results are considered to represent sufficient evidence on which to base decisions, but a judgement of sufficient evidence is also made based on the number of studies/participants included in the analysis for a particular outcome. A rating of sufficient evidence is often based on meta-analysis producing a statistically significant pooled result that is based on a large number of included studies/participants. This judgement may also be made based on the number of studies and/or study participants showing a statistically significant result - for example (in a narrative synthesis) a result where 12 studies of a total of 14 for a specific outcome showed a statistically significant effect of an intervention would be considered to represent sufficient evidence
Some evidence	Less conclusive evidence to make a decision about the effects of a particular intervention(s) in relation to a specific outcome(s). This may be based on narrative syntheses of review results. In this case, the result is qualified according to the findings of the review. This would be based on a more equivocal set of results than those obtained for 'sufficient evidence' above. For example, while 12/14 statistically significant studies would be classed as 'sufficient evidence', 5/9 statistically significant studies is more equivocal and would be classed as 'some evidence'. This may also be based on a statistically significant result obtained in a small number of studies; a statistically significant result obtained from studies with a small number of participants; or a statistically significant result obtained from studies of low quality.
Generally ineffective	Not enough evidence to support decisions about the effects of the intervention(s) on the basis of the included studies. This should be interpreted as 'no evidence of effect', rather than 'evidence of no effect'. Statistically non-significant results are considered to represent insufficient evidence. Where the number of studies is small, and/or the number of participants included in the studies is small, insufficient evidence might reflect underpowering of the included studies to be able to detect an effect of the intervention. Where the number of studies is large, and/or the number of participants included in these studies is large, 'insufficient evidence' may reflect underlying ineffectiveness of the intervention to affect the outcomes being examined. In such cases the intervention may additionally be described as 'generally ineffective' in order to separate such results from those cases where insufficient evidence is used to describe results but this is based on a small number of studies and/or participants (where non-significant results may reflect underpowering of studies rather than ineffectiveness).
Insufficient evidence to determine	Not enough evidence to be able to determine whether an intervention is effective or not on the basis of the included studies. This statement is about reporting gaps in the evidence (i.e., where there are too few studies to be able to determine effects), rather than the situation of the summary statement above, which is about ineffectiveness (e.g., several studies reporting a statistically non-significant result). It is likely to arise when the number of included studies is very small.

Supplemental Table 2. Excluded studies with reasons for exclusion

Review citation		Reasons for exclusion
1	Chavez-Rivera A, Ramos-Lira L, Abreu-Hernandez L. A systematic review of maltreatment in the medical student. Gac Med Mex. 2016 Dec 15;152:796-811.	No intervention(s).
2	Ahuja V, Nair LV, Das S, Sandhu S. Psychological stress among anesthesia residents during COVID-19 pandemic and how to mitigate them. Journal of Anaesthesiology Clinical Pharmacology. 2022 Jan 1;38(Suppl 1):S3-7.	Incorrect study design.
3	Rosa C, dos Santos Nunes E, da Costa Armstrong A. Depressão entre estudantes de medicina no Brasil: uma revisão sistemática. International Journal of Education and Health. 2021 Jan 19;5(1):133-41.	No intervention(s).
4	Uys C, Carrieri D, Mattick K. The impact of shared social spaces on the wellness and learning of junior doctors: A scoping review. Medical Education. 2023 Apr;57(4):315-30.	Incorrect population.
5	Lien YY, Lin HS, Lien YJ, Tsai CH, Wu TT, Li H, Tu YK. Challenging mental illness stigma in healthcare professionals and students: a systematic review and network meta-analysis. Psychology & Health. 2021 Jun 14;36(6):669-84.	Incorrect outcome(s).
6	Bagheri Sheykhangafshe F, Hajialiani V, Hasani J. The role of resilience and emotion regulation in psychological distress of hospital staff during the COVID-19 pandemic: A systematic review study. Journal of research and health. 2021 Nov 10;11(6):365-74.	Incorrect population.
7	Kim S, Jeong H, Cho H, Yu J. Extracurricular activities in medical education: an integrative literature review. BMC Medical Education. 2023 Dec;23(1):1-1.	No intervention(s).
8	Johnston B, Jafine H. Applied Theatre and Drama in Undergraduate Medical Education: A Scoping Review. McGill Journal of Medicine. 2022 Jul 6;20(2).	Incorrect outcome(s).
9	Wolf FM, Savickas ML, Saltzman GA, Walker ML. Meta-analytic evaluation of an interpersonal skills curriculum for medical students: Synthesizing evidence over successive occasions. Journal of counseling psychology. 1984 Apr;31(2):253.	Incorrect study design.
10	Monk A, Hind D, Crimlisk H. Balint groups in undergraduate medical education: a systematic review. Psychoanalytic Psychotherapy. 2018 Jan 2;32(1):61-86.	Incorrect outcome(s).
11	Twenge JM. Generational changes and their impact in the classroom: teaching Generation Me. Medical education. 2009 May;43(5):398-405.	Incorrect study design.
12	Salehi PP, Jacobs D, Suhail-Sindhu T, Judson BL, Azizzadeh B, Lee YH. Consequences of medical hierarchy on medical students, residents, and medical education in otolaryngology. Otolaryngology–Head and Neck Surgery. 2020 Nov;163(5):906-14.	No intervention(s).
13	Burks DJ, Kobus AM. The legacy of altruism in health care: the promotion of empathy, prosociality and humanism. Medical education. 2012 Mar;46(3):317-25.	No intervention(s).

Review citation		Reasons for exclusion
14	Kebaetse MB, Kebaetse M, Mokone GG, Nkomazana O, Mogodi M, Wright J, Falama R, Park E. Learning support interventions for Year 1 medical students: a review of the literature. Medical Education. 2018 Mar;52(3):263-73.	Incorrect intervention.
15	Sattar K, Yusoff MS, Arifin WN, Mohd Yasin MA, Mat Nor MZ. A scoping review on the relationship between mental wellbeing and medical professionalism. Medical Education Online. 2023 Dec 31;28(1):2165892.	No intervention(s).
16	Salam A, Yousuf R, Bakar SM, Haque M. Stress among medical students in Malaysia: A systematic review of literatures. Int Med J. 2013 Dec 1;20(6):649-55.	No intervention(s).
17	Elzubeir MA, Elzubeir KE, Magzoub ME. Stress and coping strategies among Arab medical students: towards a research agenda. Education for Health. 2010 Apr 1;23(1):355.	No intervention(s).
18	Wood J, Ebert L, Duff J. Implementation methods of virtual reality simulation and the impact on confidence and stress when learning patient resuscitation: An integrative review. Clinical Simulation in Nursing. 2022 May 1;66:5-17.	Incorrect intervention.
19	Milota MM, van Thiel GJ, van Delden JJ. Narrative medicine as a medical education tool: a systematic review. Medical teacher. 2019 Jul 3;41(7):802-10.	Incorrect outcome(s).
20	La Torre G, Leggieri PF, Cocchiara RA, Dorelli B, Mannocci A, Sernia S, Guerra F. Mindfulness as a tool for reducing stress in healthcare professionals: An umbrella review. Work. 2022 Aug 18(Preprint):1-1.	Incorrect study design.
21	Nemoy L. Beyond the Art of Listening: Music Research in Medical Education. InPerspectives on Arts Education Research in Canada, Volume 2 2020 Apr 30 (pp. 192-208). Brill.	Incorrect study design.
22	Dedeilia A, Sotiropoulos MG, Hanrahan JG, Janga D, Dedeilias P, Sideris M. Medical and surgical education challenges and innovations in the COVID-19 era: a systematic review. In vivo. 2020 Jun 1;34(3 suppl):1603-11.	Incorrect outcome(s).
23	Seo C, Corrado M, Fournier K, Bailey T, Haykal KA. Addressing the physician burnout epidemic with resilience curricula in medical education: a systematic review. BMC medical education. 2021 Dec;21(1):1-25.	Incorrect population.
24	Shapiro SL, Shapiro DE, Schwartz GE. Stress Management in Medical EducationTable 1. A Review of the Literature on Stress Management in Medical Education, 1969 to 1998. Academic medicine. 2000 Jul 1;75(7):748-59.	Incorrect study design.
25	Skjevik EP, Boudreau JD, Ringberg U, Schei E, Stenfors T, Kvernenes M, Ofstad EH. Group mentorship for undergraduate medical students—a systematic review. Perspectives on medical education. 2020 Oct;9:272-80.	Incorrect study design.
26	Solis AC, Lotufo-Neto F. Predictors of quality of life in Brazilian medical students: a systematic review and meta-analysis. Brazilian Journal of Psychiatry. 2019 Apr 15;41:556-67.	Incorrect intervention.

Review citation		Reasons for exclusion
27	Tarfarosh S, Achakzai BK. Promoting resilience in healthcare students through psychological interventions. BJPsych Advances. 2022 Jul;28(4):209-15.	Incorrect study design.
28	Taylor CE, Scott EJ, Owen K. Physical activity, burnout and quality of life in medical students: A systematic review. The Clinical Teacher. 2022 Dec;19(6):e13525.	No intervention(s).
29	Truong A, Wu P, Diez-Barroso R, Coverdale J. What is the efficacy of teaching psychotherapy to psychiatry residents and medical students?. Academic Psychiatry. 2015 Oct;39:575-9.	Incorrect participants.
30	Ungar P, Schindler AK, Polujanski S, Rotthoff T. Online programs to strengthen the mental health of medical students: A systematic review of the literature. Medical Education Online. 2022 Dec 31;27(1):2082909.	Incorrect study design.
31	van Ark AE, Wijnen-Meijer M. "Doctor Jazz": Lessons that medical professionals can learn from jazz musicians. Medical Teacher. 2019 Feb 1;41(2):201-6.	Incorrect participants.
32	Vernon DT, Blake RL. Does problem-based learning work? A meta-analysis of evaluative research. Academic medicine. 1993 Jul 1;68(7):550-63.	Incorrect outcome(s).
33	Walsh AL, Lehmann S, Zabinski J, Truskey M, Purvis T, Gould NF, Stagno S, Chisolm MS. Interventions to prevent and reduce burnout among undergraduate and graduate medical education trainees: a systematic review. Academic Psychiatry. 2019 Aug 15;43:386-95.	Incorrect participants.
34	Wang CX, Pavlova A, Boggiss AL, O'Callaghan A, Consedine NS. Predictors of Medical Students' compassion and related constructs: A systematic review. Teaching and learning in medicine. 2022 Jul 26:1-2.	Incorrect participants.
35	Williams D, Tricomi G, Gupta J, Janise A. Efficacy of burnout interventions in the medical education pipeline. Academic Psychiatry. 2015 Feb;39:47-54.	Incorrect participants.
36	Yazdankhahfard M, Haghani F, Omid A. The Balint group and its application in medical education: A systematic review. Journal of Education and Health Promotion. 2019;8.	Incorrect participants.
37	IsHak W, Nikravesh R, Lederer S, Perry R, Ogunyemi D, Bernstein C. Burnout in medical students: a systematic review. The clinical teacher. 2013 Aug;10(4):242-5.	No intervention(s).
38	IsHak WW, Lederer S, Mandili C, Nikravesh R, Seligman L, Vasa M, Ogunyemi D, Bernstein CA. Burnout during residency training: a literature review. Journal of graduate medical education. 2009 Dec;1(2):236-42.	Incorrect study design.
39	Kassab SE, El-Sayed W, Hamdy H. Student engagement in undergraduate medical education: A scoping review. Medical Education. 2022 Jul;56(7):703-15.	Incorrect intervention.

Review citation		Reasons for exclusion
40	Kötter T, Fuchs S, Heise M, Riemenschneider H, Sanftenberg L, Vajda C, Voigt K. What keeps medical students healthy and well? A systematic review of observational studies on protective factors for health and well-being during medical education. BMC medical education. 2019 Dec;19(1):1-6.	No intervention(s).
41	Kunzler AM, Helmreich I, König J, Chmitorz A, Wessa M, Binder H, Lieb K. Psychological interventions to foster resilience in healthcare students. Cochrane Database of Systematic Reviews 2020, Issue 7. Art. No.: CD013684. DOI: 10.1002/14651858.CD013684.	Incorrect participants.
42	Lacasse M, Audétat MC, Boileau É, Caire Fon N, Dufour MH, Laferrière MC, Lafleur A, La Rue È, Lee S, Nendaz M, Paquette Raynard E. Interventions for undergraduate and postgraduate medical learners with academic difficulties: A BEME systematic review: BEME guide no. 56. Medical teacher. 2019 Sep 2;41(9):981-1001.	Incorrect outcome(s).
43	Lee A, Niu B, Balaa F, Gawad N. When Illness and Loss Hit Close to Home—Do Health Care Providers Learn How to Cope?. Journal of Continuing Education in the Health Professions. 2022 May 17:10-97.	Incorrect participants.
44	Lo K, Waterland J, Todd P, Gupta T, Bearman M, Hassed C, Keating JL. Group interventions to promote mental health in health professional education: a systematic review and meta-analysis of randomised controlled trials. Advances in Health Sciences Education. 2018 May;23:413-47.	Incorrect participants.
45	Lovell B. What do we know about coaching in medical education? A literature review. Medical education. 2018 Apr;52(4):376-90.	Incorrect study design.
46	Maity S, Wray J, Coffin T, Nath R, Nauhria S, Sah R, Waechter R, Ramdass P, Nauhria S. Academic and Social Impact of Menstrual Disturbances in Female Medical Students: A Systematic Review and Meta-Analysis. Frontiers in Medicine. 2022;9.	Incorrect participants.
47	McConville J, McAleer R, Hahne A. 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. Explore. 2017 Jan 1;13(1):26-45.	Incorrect participants.
48	Mogre V, Amoore BY, Gaa PK. A scoping review of nutrition education interventions to improve competencies, lifestyle and dietary habits of medical students and residents. Journal of Nutritional Science. 2023;12:e31.	Incorrect participants.
49	Moss SJ, Wollny K, Amarbayan M, Lorenzetti DL, Kassam A. Interventions to improve the well-being of medical learners in Canada: a scoping review. Canadian Medical Association Open Access Journal. 2021 Jul 1;9(3):E765-76.	Incorrect participants.
50	Ong RS, Wong RS, Chee RC, Quek CW, Burla N, Loh CY, Wong YA, Chok AK, Teo AY, Panda A, Chan SW. A systematic scoping review moral distress amongst medical students. BMC medical education. 2022 Dec;22(1):1-21.	Incorrect study design.
51	Sekhar P, Tee QX, Ashraf G, Trinh D, Shachar J, Jiang A, Hewitt J, Green S, Turner T. Mindfulness-based psychological interventions for improving mental well-being in medical students and junior doctors. Cochrane Database of Systematic Reviews. 2021(12).	Incorrect participants.

Review citation		Reasons for exclusion
52	Wesslund HM, Payne JS, Baxter JD, Westmark DM, Bartels K, Bailey KL, Krutsinger DC. Personal Financial Wellness Curricula for Medical Trainees: A Systematic Review. Academic Medicine. 2023 Jan 3:10-97.	Incorrect participants.
53	Crozier D, Greene A, Schleicher M, Goldfarb J. Teaching spirituality to medical students: a systematic review. Journal of Health Care Chaplaincy. 2022 Jul 3;28(3):378-99.	Incorrect outcome(s).
54	Esan O, Esan A, Folasire A, Oluwajulugbe P. Mental health and wellbeing of medical students in Nigeria: a systematic review. International Review of Psychiatry. 2019 Nov 17;31(7-8):661-72.	Incorrect study design.
55	Fares J, Al Tabosh H, Saadeddin Z, El Mouhayyar C, Aridi H. Stress, burnout and coping strategies in preclinical medical students. North American journal of medical sciences. 2016 Feb;8(2):75.	Incorrect study design.
56	Farkas AH, Allenbaugh J, Bonifacino E, Turner R, Corbelli JA. Mentorship of US medical students: a systematic review. Journal of general internal medicine. 2019 Nov;34:2602-9.	Incorrect outcome(s).
57	Fisch S, Brinkhaus B, Teut M. Hypnosis in patients with perceived stress–a systematic review. BMC complementary and alternative medicine. 2017 Dec;17(1):1-2.	Incorrect participants.
58	Cohaila JA. Factors associated with medical students scores on the National Licensing Exam in Peru: a systematic review. Journal of Educational Evaluation for Health Professions. 2022;19:38.	Incorrect study design.
59	Franco RS, dos Santos Franco CA, Severo M, Ferreira MA, Karnieli-Miller O. Reflective writing in the teaching of communication skills for medical students—a systematic review. Patient education and counseling. 2022 Jan 12.	Incorrect outcome(s).
60	Frei E, Stamm M, Buddeberg-Fischer B. Mentoring programs for medical students-a review of the PubMed literature 2000-2008. BMC medical education. 2010 Dec;10:1-4.	Incorrect study design.
61	Guckian J, Utukuri M, Asif A, Burton O, Adeyoju J, Oumeziane A, Chu T, Rees EL. Social media in undergraduate medical education: A systematic review. Medical Education. 2021 Nov;55(11):1227-41.	Incorrect outcome(s).
62	Haidet P, Jarecke J, Adams NE, Stuckey HL, Green MJ, Shapiro D, Teal CR, Wolpaw DR. A guiding framework to maximise the power of the arts in medical education: a systematic review and metasynthesis. Medical education. 2016 Mar;50(3):320-31	Incorrect study design.
63	Hathaisaard C, Wannarit K, Pattanaseri K. Mindfulness-based interventions reducing and preventing stress and burnout in medical students: A systematic review and meta-analysis. Asian Journal of Psychiatry. 2022 Mar 1;69:102997.	Incorrect participants.
64	Heim E, Henderson C, Kohrt BA, Koschorke M, Milenova M, Thornicroft G. Reducing mental health-related stigma among medical and nursing students in low-and middle-income countries: a systematic review. Epidemiology and psychiatric sciences. 2020;29:e28.	Incorrect participants.

Review citation		Reasons for exclusion
65	Patel P, Hancock J, Rogers M, Pollard SR. Improving uncertainty tolerance in medical students: A scoping review. Medical Education. 2022 Dec;56(12):1163-73.	Incorrect outcome(s).
66	Polle E, Gair J. Mindfulness-based stress reduction for medical students: a narrative review. Canadian Medical Education Journal. 2021 May 13;12(2):e74-80.	Incorrect study design.
67	Rogers D. Which educational interventions improve healthcare professionals' resilience?. Medical teacher. 2016 Dec 1;38(12):1236-41.	Incorrect participant(s).
68	Akinla O, Hagan P, Atiomo W. A systematic review of the literature describing the outcomes of near-peer mentoring programs for first year medical students. BMC medical education. 2018 Dec;18(1):1-0.	Incorrect study design.
69	Alkhaifi M, Clayton A, Kangasjarvi E, Kishibe T, Simpson JS. Visual art-based training in undergraduate medical education: A systematic review. Medical Teacher. 2022 May 4;44(5):500-9.	Incorrect participants.
70	Ardekani A, Hosseini SA, Tabari P, Rahimian Z, Feili A, Amini M, Mani A. Student support systems for undergraduate medical students during the COVID-19 pandemic: a systematic narrative review of the literature. BMC Medical Education. 2021 Jun 22;21(1):352.	Incorrect intervention.
71	Aryankhesal A, Mohammadibakhsh R, Hamidi Y, Alidoost S, Behzadifar M, Sohrabi R, Farhadi Z. Interventions on reducing burnout in physicians and nurses: A systematic review. Medical journal of the Islamic Republic of Iran. 2019;33:77.	Incorrect participants.
72	Atlas AM, Seltzer ES, Watters A, Riley B, Chan T. A global perspective of mentorship in medical schools: systematic review from 2014 to 2019. Medical Science Educator. 2021 Apr;31:969-77.	Incorrect outcome(s).
73	Buck E, Holden M, Szauter K. Changes in humanism during medical school: A synthesis of the evidence. Medical Science Educator. 2017 Dec;27:887-93.	No intervention(s).
74	Chen I, Forbes C. Reflective writing and its impact on empathy in medical education: systematic review. Journal of educational evaluation for health professions. 2014 Aug 16;11.	Incorrect participants.
75	Cocchiara RA, Peruzzo M, Mannocci A, Ottolenghi L, Villari P, Polimeni A, Guerra F, La Torre G. The use of yoga to manage stress and burnout in healthcare workers: a systematic review. Journal of clinical medicine. 2019 Feb 26;8(3):284.	Incorrect participants.
76	Coronado-Vázquez V, Antón-Rodríguez C, Gómez-Salgado J, del Valle Ramírez-Durán M, Álvarez-Montero S. Evaluation of learning outcomes of humanities curricula in medical students. A meta-review of narrative and systematic reviews. Frontiers in Medicine. 2023;10.	Incorrect study design.
77	Horiuchi S, Flusberg Y, Peterson CT, Mills PJ, Chopra D, Kogan M. Current approaches to yoga in US Medical schools: Scoping review of the literature. Journal of integrative and complementary medicine. 2022 Jun 1;28(6):463-73.	Incorrect study design.

Review citation		**Reasons for exclusion**
78	Keren D, Lockyer J, Ellaway RH. Social studying and learning among medical students: a scoping review. Perspectives on medical education. 2017 Oct;6:311-8.	No intervention(s).

Supplemental Table 3. Quality appraisal of included reviews using AMSTAR-2

Domains*	**Review citation**												
	Buizza et al. 2020	**Da Silva et al. 2023**	**Daya and Hearn, 2018**	**Frajerman, 2020**	**Kusuma-dewi et al. 2021**	**McCray et al. 2008**	**Regehr et al. 2014**	**Shiralkar et al. 2013**	**Spring et al. 2011**	**Wasson et al. 2016**	**Witt et al. 2019**	**Yoge-swaran and El Morr, 2021**	**Yusoff, 2014**
1. Did the inclusion criteria include components of PICO?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	No	Yes
2. Did the report explicitly state the use of an 'a priori' design (protocol)?	Yes	Yes	No	No	Yes	No	No	No	No	Partial yes	No	Yes	No
3. Was selection of study designs for inclusion explained?	No	Yes	No	No	No	No	Yes	No	No	Yes	No	No	No
4. Was a comprehensive literature search strategy used?	Partial yes	Partial yes	Partial yes	No	Partial yes	Partial yes	Partial yes	Partial yes	Yes	Yes	Yes	Partial yes	Partial yes
5. Was study selection performed in duplicate?	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
6. Was data extraction performed in duplicate?	Yes	Yes	Yes	No	Yes	Yes	No	No	No	Yes	Yes	Yes	No
7. Was a list of excluded with reasons provided?	No	No	No	Yes	No	No	No	No	No	No	No	No	No
8. Were included studies described in adequate detail?	Yes	Yes	Yes	Partial yes	Yes	Yes	Partial yes	Partial yes	Yes	Yes	Yes	Yes	Partial yes

Domains*	Review citation												
	Buizza et al. 2020	**Da Silva et al. 2023**	**Daya and Hearn, 2018**	**Frajerman, 2020**	**Kusuma-dewi et al. 2021**	**McCray et al. 2008**	**Regehr et al. 2014**	**Shiralkar et al. 2013**	**Spring et al. 2011**	**Wasson et al. 2016**	**Witt et al. 2019**	**Yoge-swaran and El Morr, 2021**	**Yusoff, 2014**
9. Was a satisfactory technique used to assess primary study risk of bias?	Yes	Yes	Yes	No	Yes	No	Yes	Yes	No	Yes	Yes	No	No
10. Was funding for primary studies reported?	No	Yes	No	No	No	No	No	No	No	No	No	No	No
11. If meta-analysis was performed did authors use appropriate methods for statistical combination of results?	N/A	Yes	N/A	N/A	N/A	N/A	Yes	N/A	N/A	N/A	Yes	N/A	Yes
12. If meta-analysis was performed, did the review authors assess the potential impact of RoB in individual studies on the results of the meta-analysis or other evidence synthesis?	N/A	No	N/A	N/A	N/A	N/A	No	N/A	N/A	N/A	No	N/A	Yes
13. Did the review authors account for RoB in individual studies when interpreting/discussing	No	Yes	Yes	No	Yes	No	Yes	Yes	No	Yes	Yes	No	No

Domains*	**Review citation**												
	Buizza et al. 2020	**Da Silva et al. 2023**	**Daya and Hearn, 2018**	**Frajerman, 2020**	**Kusuma-dewi et al. 2021**	**McCray et al. 2008**	**Regehr et al. 2014**	**Shiralkar et al. 2013**	**Spring et al. 2011**	**Wasson et al. 2016**	**Witt et al. 2019**	**Yoge-swaran and El Morr, 2021**	**Yusoff, 2014**
the results of the review?													
14. Were reasons for heterogeneity discussed and/or explained?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
15. If they performed quantitative synthesis did the review authors carry out an adequate investigation of publication bias (small study bias) and discuss its likely impact on the results of the review?	N/A	No	N/A	N/A	N/A	N/A	No	N/A	N/A	N/A	No	N/A	Yes
16. Did the review authors report any potential sources of conflict of interest, including any funding they received for conducting the review?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Rating of overall confidence in the results of the review	**Critically low**	**Critically low**	**Critically low**	**Critically low**	**Low**	**Critically low**	**Critically low**	**Critically low**	**Critically low**	**Low**	**Critically low**	**Critically low**	**Critically low**

*Critical domains denoted by emboldened text

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1. Ryan RE, Santesso N, Lowe D, et al. Interventions to improve safe and effective medicines use by consumers: an overview of systematic reviews. *Cochrane Database of Systematic Reviews*. 2014;(4)