

Effectiveness of universal programs for the prevention of suicidal ideation and behaviours in medical students: A systematic review and meta-analysis

Katrina WITT (D.Phil);^{1,2,*} Alexandra BOLAND (BA);²

Michelle LAMBLIN (BSc [Hons]);² Patrick McGORRY (MD; FRANZCP);²

Benjamin VENESS (MBBS);³ Andrea CIPRIANI (MD);⁴ Keith HAWTON (FMedSci);⁵

Samuel HARVEY (PhD)⁶ and Jo ROBINSON (PhD)²

¹ Turning Point, Eastern Health Clinical School, Monash University, Melbourne, AUSTRALIA.

² Orygen, The National Centre for Excellence in Youth Mental Health, University of Melbourne, Melbourne, AUSTRALIA.

³ Alfred Health, Melbourne, AUSTRALIA.

⁴ Department of Psychiatry, University of Oxford, Oxford, UNITED KINGDOM.

⁵ Centre for Suicide Research, Department of Psychiatry, University of Oxford, Oxford, UNITED KINGDOM.

⁶ Black Dog Institute, University of New South Wales, Sydney, AUSTRALIA.

* Address for correspondence:

Turning Point, Eastern Health Clinical School, Monash University
110 Church Street, Richmond, VIC, 3121.

Ph: +61 (0)3 8413 8512

E: katrina.witt@monash.edu

Word Count: 3,674.

ABSTRACT

Objectives: A growing body of work suggests that medical students may be particularly at risk of suicidal ideation and behaviour, resulting in recent calls to develop interventions to prevent these outcomes in medical students. However, few reviews have synthesised the current evidence base regarding the effectiveness of these interventions and provided guidance to improve future suicide prevention efforts.

Study design: We conducted a systematic review to identify studies of any design reporting the effectiveness of any universal intervention to address suicidal ideation or behaviour in medical students. Given their association with suicidal ideation and behaviour, we also investigated secondary outcomes related to depression, anxiety, stress and burnout.

Data sources: Embase, Medline and PsycINFO databases were searched from their respective start dates until 1 December, 2017.

Data synthesis: We included data from 39 studies. Most investigated the effectiveness of relatively brief interventions designed to reduce stress; most commonly using mindfulness-based or guided meditation approaches. Only one implemented an intervention specifically designed to address suicidal ideation; none investigated the effectiveness of an intervention specifically designed to address suicidal behaviour. Five investigated the effects of moving to a problem-based curriculum. Overall, there was limited evidence of an effect for these programs at both the post-intervention and longest follow-up assessment on depression, anxiety, and stress.

Conclusions: Relatively brief, individually-focused, mindfulness-based stress-management interventions may be effective in reducing levels of anxiety, depression and stress in medical students in the short-term. Effects on suicidal ideation and behaviour, however, remain to be determined. There has been a significant lack of attention on organisational-level stressors associated with medical education and training.

Keywords: suicidal ideation; medical students; anxiety; stress; depression.

The known

Medical students are at increased risk of suicidal ideation and behaviour as compared to their counterparts studying for other degrees. Medical students experience a unique variety of stressors that may be specific to medical education, and students frequently identify the format and delivery of the medical curricula as a particular source of stress. Knowledge of effective interventions for reducing suicidal ideation and behaviour in medical students is limited.

The new

Mindfulness-based stress-management training may be an effective short-term intervention for medical students experiencing anxiety, depression and stress. At the longest follow-up time assessment, however, there was limited evidence of an enduring effect for these programs; although fewer studies reported data at longer-term follow-up. There has been little attention given to the effectiveness of organisational-level interventions or interventions specifically designed to reduce suicidal ideation and behaviour, despite increasing concerns around suicide in this population.

The implications

Our findings highlight the importance of interventions directed towards improving medical students' mental health, whilst decreasing anxiety, depression and stress. These programs should be delivered in an ongoing, consistent, and meaningful way across all years of medical education and should be targeted to specifically address mental health, suicidal ideation, and suicidal behaviour, rather than focusing on individual resiliency or overall well-being. There needs to be further investigation of organisational-level interventions and interventions that target suicidal ideation and behaviour.

INTRODUCTION

Despite suicide being a leading cause of death for those between 15 and 29 years of age globally (1), to date, most population-level interventions to reduce suicidal ideation and behaviour in young people have focused on school settings (2). Whilst lower rates of suicide have been observed in tertiary students compared to their non-tertiary educated peers (3), higher rates of suicidal ideation and behaviour have been reported, suggesting this population is still at risk (4).

Medical students may be particularly at risk of depression and suicidal ideation and behaviour. In a large meta-analysis, almost one-third (27.2%) of medical students had depression or symptoms of depression and around one-in-ten (11.1%) reported suicidal ideation (5). Medical students have also been shown to report lower quality of life (6), and higher levels of anxiety (7), stress (8), and psychological distress (9, 10). This may be due to a range of unique stressors, including a demanding study load which may reduce available time for self-care (11) and frequent exposure to death and dying in patients, including suicide death (12).

The format and delivery of medical curricula has also been identified as a specific source of stress (13). For example, frequent examinations (14-17); lengthy academic curricula (17); tiered, rather than pass/fail, grading systems (18); a mismatch between preferred teaching and learning styles (19); and lack of preparation for career transitions, in particular between preclinical and clinical training (20, 21), have all been associated with poorer mental health outcomes in medical students. The structure of medical school curriculum therefore offers a significant opportunity for interventions (22).

Whilst a number of universal interventions have been developed to improve general well-being in medical students, these have predominately focused on improving individual resilience (23) and have not addressed the cultural, systemic and structural factors that may impact upon well-being.

Previous reviews of interventions to prevent suicidal ideation and behaviour in tertiary settings have demonstrated limited effectiveness in medical students specifically (24). This may be attributable to the unique organisational-level stressors experienced by medical students. Therefore, we have conducted a systematic review and meta-analysis of universal interventions aimed at addressing suicidal ideation and behaviour in medical students. Given their association with suicidal ideation and behaviour, we have also included interventions targeting depression, anxiety, stress, and burnout (25, 26).

METHOD

Search strategy and study selection

We searched Embase, Medline, and PsycINFO until 1 December, 2017. Ancestry searches were also conducted to locate relevant studies inadvertently missed by the electronic search. Further detail on the electronic search strategy is available in Appendix 1.

Studies were eligible for inclusion in this review if: (1) they were a randomised controlled trial (RCT), including both cluster RCT (cRCTs) and cross-over RCTs, a non-randomised controlled trial (non-RCT), a historically controlled, or uncontrolled longitudinal design; (2) the effectiveness of a universal intervention to address suicidal ideation, suicidal behaviour,

depression, anxiety, stress and/or burnout was evaluated in the study; (3) participants were medical students; and (4) they were published in English.

All retrieved articles were double-screened by KW and AB independently. Disagreements were resolved through consensus discussions with ML, JR and BV.

Data extraction

KW and AB independently extracted data and methodological information. The primary outcome assessed was suicidal ideation. Secondary outcome measures included: suicidal behaviour (i.e., self-harm, attempted suicide, and suicide deaths), depression, anxiety, stress, and burnout. For each outcome, data were extracted at post-intervention and, where possible, at the longest follow-up assessment point.

For each study we also extracted information on: (1) study characteristics (e.g., first author, year, location); (2) participant demographics (e.g., year at medical school, whether undergraduate or graduate-entry, average age, gender composition); (3) study design; (4) the intervention (e.g., broad therapeutic focus, number of sessions); (5) what intervention, if any, the control group received; (6) duration and intensity of the intervention, and; (7) the outcomes assessed and how these were operationalised.

Study quality

KW and AB independently assessed the quality of each included study. We used the following tools for the different categories of study design included in the review: (1) the Cochrane Risk of Bias tool for RCTs (27); (2) the Risk of Bias In Non-randomised Studies of Interventions

(ROBINS-I) tool for non-RCTs (28), and; (3) the Newcastle-Ottawa Scale (NOS) for longitudinal studies.

Data synthesis and statistical analysis

Where possible we synthesised quantitative data between studies using meta-analysis. For continuous outcome data we calculated the standardised mean difference (SMD) with corresponding 95% confidence intervals (CI). For dichotomous outcome measures we calculated the pooled odds ratio (OR) with corresponding 95% CI. Data synthesis was undertaken in Review Manager (RevMan) for Windows, version 5.3 (29), by implementing the DerSimonian and Laird random effects model.

RESULTS

Overall, 1,505 records were identified from the electronic databases and additional 116 records were identified through hand searching (Appendix 1). After removing duplicates and title screening, 314 full text articles were retrieved for further screening. Finally, a total of 39 studies were included in the systematic review (Figure 1).

**** FIGURE 1 HERE ****

Characteristics of the included studies

Further details on the characteristics of the included studies are provided in Table 1. Of the 39 studies included in the review, over half (k=24; 61.5%) were conducted in the USA and around one third of studies utilised an RCT design (13 studies; 33.3%).

**** TABLE 1 HERE ****

Only one study investigated the effectiveness of an intervention specifically designed to address suicidal ideation (30); none reported information of the effectiveness of these programs for suicidal behaviour. Most studies investigated programs designed to reduce stress (k=27; 69.2%), anxiety (k=8; 20.5%) or depression (k=8; 20.5%).

Most interventions were relatively brief (i.e., between one to 16 sessions; mean 4.9) delivered according to mindfulness-based principles (k=18; 46.1%) (30-47), stress management training (k=5; 12.8%) (48-52), psychoeducation (k=4; 10.2%) (53-56), relaxation training (k=2; 5.1%), (57, 58) or yoga (k=2; 5.1%) (59, 60). Other approaches evaluated in single studies included: telephone counselling (61), omega-three fatty acid supplementation (62), and visual journaling (63). Five studies (12.8%) investigated the effectiveness of changing from a didactic lecture-based curriculum format to a problem-based format on reducing stress (64-68); however, for one of these, insufficient data on our primary or secondary outcomes were reported to enable inclusion in any meta-analysis (68).

Characteristics of the included participants

The 39 studies included a total of 7,387 medical students (range: 5 to 1,958) aged between 18 and 32 years of age. Twenty-five studies included information on the gender of participants; in 21 (84.0%) of these, women formed the majority of participants.

Study quality

Owing to the difficulty in ensuring participants and research personnel were blinded to treatment allocation, all RCTs were rated as at unclear risk of bias for these domains (Appendix 2). Similarly, all non-RCTs were downgraded owing to a lack of information on bias in the classification of the intervention being reported (Appendix 3). For historically controlled studies, most received between three and five stars on the Newcastle-Ottawa Scale, suggesting a moderate to high risk of bias for these studies, with biases most apparent for comparability of the historical control cohort (Appendix 4). Finally, for uncontrolled longitudinal studies, bias was most apparent for the measurement of the outcome measure as all studies relied on self-reported information (Appendix 4).

Effects of individually-focused interventions

Suicidal ideation

None of the studies included information on the proportion of participants reporting suicidal ideation or on suicidal ideation scores at post-intervention. One study included data on suicidal ideation at the longest follow-up point (i.e., one year). There was some evidence of a moderate reduction in the proportion of participants reporting suicidal ideation by this time point in one historically controlled trial of psychoeducation (OR 0.07, 95% CI 0.01 to 0.59; 1 study) (30).

Depression

One uncontrolled longitudinal study of a yoga program included data on the proportion of participants reporting depression at the post-intervention assessment (60); however, there was no evidence of a significant treatment effect for this programs (OR 0.27, 95% CI 0.05 to 1.36; 1 study).

There was also no apparent effect on depression scores (measured continuously) in six RCTs of predominately mindfulness programs (SMD -0.46, 95% CI -1.15 to 0.23; 6 studies; I^2 93.0%; Figure 2). There was also no apparent effect in a single RCT of omega-three fatty acid supplementation (SMD 0.00, 95% CI -0.48 to 0.48), or in one non-RCT of guided meditation (SMD -0.08, 95% CI -0.32 to 0.16; 1 study; Figure 2) (40) at the post-intervention assessment. In six uncontrolled longitudinal studies of a diverse range of interventions (including relaxation training, yoga, and psychoeducation) there was an apparent effect on depression scores (SMD -0.26, 95% CI -0.43 to -0.10; 6 studies; I^2 0.0%; Figure 2) (34, 37, 45, 53, 59, 60); however, this effect was reduced following the exclusion of studies in which graduate entry medical students were recruited (SMD -0.18, 95% CI -0.40 to 0.05; 2 studies; I^2 0.0%). The exclusion

of such studies made no overall difference to either the magnitude or direction of the effect for all other study designs.

**** FIGURE 2 HERE ****

By the longest follow-up assessment (i.e., three months), there was no evidence of a significant effect of guided meditation on the proportion of participants reporting depression in one non-RCT (OR 1.39, 95% CI 0.48 to 4.01; 1 study) (35). However, there was some evidence of a significant reduction in the proportion reporting depression by this time point in one historically controlled trial of a psychoeducation program (OR 0.30; 95% CI 0.12 to 0.75; 1 study) (30). Despite differences in the magnitude of the OR between these studies, there was no evidence of a significant subgroup difference by study design.

There was, however, a significant effect on depression scores at the longest follow-up point for stress management programs, including mindfulness and psychoeducation approaches in three RCTs (SMD -0.33, 95% CI -0.55 to -0.10; 3 studies; I^2 10.0%; Figure 3) (41, 49, 54), although there was no evidence of a similar effect in one non-RCT of psychoeducation (SMD 0.45, 95% CI -0.19 to 1.09; 1 study; Figure 3) (52). There was no evidence of a significant subgroup difference by study design.

**** FIGURE 3 HERE ****

Anxiety

No study included data on the proportion of participants reporting anxiety at the post-intervention assessment. There was no evidence of a significant treatment effect on end-of-treatment anxiety scores in five RCTs of predominately mindfulness-based interventions (SMD -0.62, 95% CI -1.63 to 0.38; 5 studies; I^2 97.0%; Figure 4) (39, 41, 43, 49, 58, 62). There was some evidence of a modest treatment effect in favour a single trial of omega-3 essential fatty acid supplementation on anxiety scores at post-intervention (SMD -0.74, 95% CI -1.23 to -0.25) (62).

**** FIGURE 4 ****

There was some evidence that guided meditation and a group-based stress management program may be associated with a reduction in anxiety scores at post-intervention based on three non-RCTs (SMD -0.27, 95% CI -0.48 to -0.07; 3 studies; I^2 0.0%; Figure 4) (35, 40, 51). A positive effect was also found in five uncontrolled longitudinal studies which evaluated a number of different approaches designed to reduce anxiety and stress (SMD -0.41, 95% CI -0.76 to -0.06; 6 studies; I^2 69.0%; Figure 4) (34, 37, 53, 59, 61). The overall test for subgroup differences by study design was not significant (Figure 4). The effect in favour of stress management programs on anxiety scores in uncontrolled longitudinal studies was reduced following the exclusion of studies in which graduate-entry medical students were recruited (SMD -0.12, 95% CI -0.35 to 0.10; 1 study). The exclusion of these studies made no overall difference to either the magnitude or direction of the effect for anxiety scores for all other study designs.

No included study reported data on the proportion of students reporting anxiety at the final follow-up assessment. In terms of anxiety scores, there was no evidence of a significant treatment effect of a multicomponent stress management program in one RCT (SMD 0.31, 95% CI -0.03 to 0.66; 1 study; Figure 5) (49). There was, however, some suggestion of an *increase* in anxiety scores at final follow-up in two non-RCTs of guided meditation and psychoeducation respectively (SMD 0.51, 95% CI 0.10 to 0.91; 2 studies; I^2 0.0%; Figure 5) (35, 52). The test for subgroup differences by study design was, as a consequence, significant ($\chi^2=7.53$, $p=0.02$).

**** FIGURE 5 HERE ****

Stress

No study included data on the proportion of participants reporting stress at post-intervention.

There was no evidence of a significant treatment effect of a mindfulness program on stress scores at post-intervention in one RCT (SMD -0.32, 95% CI -1.04 to 0.40; 1 study; Figure 6) (43), nor for a group-based stress management program in one non-RCT (SMD -0.38, 95% CI -1.00 to 0.25; 1 study; Figure 6) (51). However, there was some evidence that these programs may be associated with a modest reduction in stress in three uncontrolled longitudinal studies (SMD -0.66, 95% CI -1.32 to -0.00; 3 studies; I^2 81.0%; Figure 6) (36, 45, 60). Despite these differences, there was no evidence of a significant subgroup difference by study design (Figure 6).

**** FIGURE 6 HERE ****

No included study reported data on the proportion of students reporting stress at final follow-up. However, two RCTs of mindfulness programs (33, 44), and one historically controlled trial of a group-based stress management program (48), included information on stress scores at the final follow-up assessment. Whilst mindfulness programs were associated with a modest effect for stress scores by this time point in two RCTs (SMD -0.28, 95% CI -0.49 to -0.07; 2 studies; I^2 0.0%; Figure 7), there was no similar effect found in one historically controlled trial of a group-based psychoeducation program (SMD -0.03, 95% CI -0.38 to 0.32; 1 study; Figure 7).

**** FIGURE 7 HERE ****

Burnout

No included study reported data either on the proportions of participants reporting burnout or on burnout scores at the post-intervention assessment point.

No study included data on the proportion of students reporting burnout at the final follow-up assessment. One RCT did, however, include information on the effectiveness of a mindfulness program on burnout scores, with no evidence of a significant effect for this program by the longest follow-up assessment (SDM -0.13, 95% CI -0.36 to 0.10; 1 study) (33).

Effects of curriculum-based interventions

Suicidal ideation

No study of a curriculum-based intervention reported data on suicidal ideation at either the post-intervention or longest follow-up points.

Depression

There was no evidence of a treatment effect in favour of curriculum-based interventions on the proportion reporting symptoms of depression by the post-intervention assessment in a single study (65) (OR 0.11, 95% CI 0.01 to 1.79; 1 study), or by the longest follow-up assessment in another single study (OR 0.80, 95% CI 0.47 to 1.38; 1 study) (64).

There was no evidence of a significant reduction in depression scores in one study of a curriculum-based intervention by the longest follow-up assessment (SMD -0.16, 95% CI -0.38 to 0.06; 1 study) (64).

Anxiety

No study of curriculum-based interventions reported data on anxiety at the post-intervention assessment. By the longest follow-up assessment, there was no evidence of a reduction in anxiety scores in a single study (SMD -0.02, 95% CI -0.17 to 0.14; 1 study) (67).

Stress

No study of a curriculum-based intervention reported data on stress at either the post-intervention or longest follow-up points.

Burnout

No study of a curriculum-based intervention reported data on burnout at either the post-intervention or longest follow-up points.

DISCUSSION

Key findings

This review included data from 38 individual studies. Despite recent concerns around suicide rates in both medical students and doctors-in-training, we found only one study that evaluated outcomes related to suicidal ideation, and none reported outcomes relating to suicidal behaviour. Data from the included studies would suggest there is limited evidence that relatively brief, individually-focused mindfulness-based interventions may be effective in reducing levels of anxiety, depression, and stress in medical students; although the magnitude of the effect tended to be greater for non-RCTs and uncontrolled longitudinal studies as compared with RCTs.

Most included studies investigated the effectiveness of relatively brief programs for the management of stress, typically comprising between one to 16 sessions (mean 4.9), delivered over a short time period (mean duration: 8 weeks). Most interventions were offered during the pre-clinical years; however, some evidence suggests that levels of suicidal ideation (69), depression (70, 71), psychological distress (72), and stress (71) increase throughout the course of the medical degree, peaking in the clinical years of training (73). Additionally, stressors likely differ between students in their pre-clinical years as opposed to those in their clinical training years. In Australia at least, common stressors include the increased pressures of having to fit into, and rotate quickly through, a series of busy clinical environments, many of which

may seem unwelcoming and confronting to students. Therefore, it is difficult to assess the effectiveness of such interventions across different stages of medical education. Future interventions developed for this population should place greater focus on times of elevated stress.

Only four studies investigated the effects of curriculum-based interventions on mental health outcomes for medical students, despite students frequently identifying the structure and format of curricula as a particular source of stress (13). At present there is no evidence from these studies to suggest that changing classes from a didactic lecture-based format to a problem-based format has an effect on reducing levels of anxiety, depression or suicidal ideation. It is, however, notable that a number of studies of curriculum-based interventions were excluded from the present review as they did not report data on any of the outcomes of interest. These interventions are therefore worth further investigation.

Limitations of the present review

Most included studies were conducted in the USA, where the structure of medical education is different to that in many other countries. In the USA, students complete a pre-medical undergraduate degree before commencing their medical education as graduate-entry students. In other countries, including Australia and the UK, students have the option to commence their medical education either as undergraduates or as graduate-entry students. Similar levels of anxiety, depression and stress have, however, been noted in graduate-entry medical students as compared to their school-leaving counterparts (74), suggesting that stressors experienced by both undergraduate and graduate-entry medical students are likely to be similar, and these common stressors are likely related to factors specific to medical education. We also investigated the effect of including studies in which students were enrolled in a graduate-entry

medical degree as opposed to an undergraduate degree, and found effects in favour of individually-focused interventions were reduced following the exclusion of studies that predominately recruited graduate-entry medical students. Given that the majority of these studies were conducted in the USA, however, it is difficult to determine whether there may be systematic differences in the magnitude of the effects by educational level.

Studies included in this review focussed on interventions intended to address depression, anxiety, and stress at the universal level, in other words, before individuals were displaying symptoms. This may therefore explain why a number of programs demonstrated limited effectiveness for these outcomes as universal interventions may be better designed to target everyone regardless of risk (i.e., to prevent depression or anxiety) rather than trying to reduce symptoms.

This review aimed to investigate the full spectrum of interventions for the prevention of suicidal ideation and behaviour in medical students and, as such, many meta-analyses pool data across a variety of intervention approaches. This may have resulted in the very high levels of heterogeneity, denoted by the I^2 values for some of the results; principally for depression and stress scores at post-intervention, and anxiety scores at longest follow-up. However, sensitivity analyses omitting studies characterised by very different intervention approaches from the majority in each of these analyses did not significantly reduce heterogeneity for these outcomes, suggesting that factors other than intervention approach may also contribute to the variability in treatment effect for these interventions.

The included studies were generally of moderate quality. Fourteen studies were downgraded due to the predominately psychological nature of the interventions tested and the subsequent difficulty in ensuring participants and research personnel were blinded to treatment allocation.

Similarly, all non-RCTs were downgraded owing to a lack of information on the methods used to classify the intervention. For historically-controlled studies, most received between three and five stars on the NOS, suggesting moderate to low quality, with biases most apparent for comparability of the historical control and intervention cohorts. Finally, for uncontrolled cohort studies, bias was most apparent for the measurement of outcome measures as all studies relied on self-reported information, a common limitation of many suicide prevention initiatives (75).

Implications

While suicide is the leading cause of death for those between 15 and 29 years of age globally (1), much suicide prevention work to date is offered in school settings, with tertiary settings lagging behind (2, 24). It has previously been argued that there is a need for high quality studies in tertiary education settings (24). Given the unique challenges associated with medical education, interventions specifically tailored to medical schools are warranted as a priority.

The majority of studies reported in this review focused on individual-level interventions to improve students' resilience, and largely ignored the role of the inherent structural and systemic stressors. Medical students are exposed to a number of organisational-level stressors, some of which are relatively inherent to medical training and may be difficult to modify in the short term, whilst others constitute preventable systems-level failures, such as the fostering of a competitive culture that rewards overwork and environments permissive of intimidation and bullying (76). Interventions that address these organisational stressors should therefore be prominent in any intervention aimed at reducing suicidal ideation and behaviour, and mental ill-health more generally in this population (47). Given that a significant time at medical school is spent in clinical settings, systemic interventions may simultaneously benefit both medical students and doctors-in-training. Interventions should aim to reduce the stigma associated with

mental ill-health, suicidal ideation and behaviour amongst this population; one approach to this might be by amending mandatory reporting laws to exempt treating health practitioners (76), as these may act as a barrier to help-seeking.

Conclusions

Whilst relatively brief mindfulness-based stress-management interventions may be effective in reducing levels of anxiety, depression and stress in medical students in the short-term, long-term effects on these outcomes, and for suicidal ideation at any time point, remain to be determined. There has been a significant lack of attention to organisational-level stressors associated with medical education and training. Given rates of suicidal ideation and behaviour in medical students and the levels of community concern around suicide in this population, further work examining the effects of both individual and organisational-level interventions, across all the years of medical education, is urgently required.

Competing Interests Statement

Competing interests: No relevant disclosures.

Acknowledgements

The study was funded by the Commonwealth of Australia Department of Health. JR is funded by a National Health and Medical Research Council Career Development Fellowship (ID1142348). KW is funded by a post-doctoral fellowship awarded by the American Foundation for Suicide Prevention (PDF-0-145-16).

REFERENCES

1. World Health Organization Preventing Suicide: A Global Imperative. Geneva, Switzerland: World Health Organization, 2014.
2. De Silva S, Parker A, Purcell R, et al. Mapping the evidence of prevention and intervention studies for suicidal and self-harming behaviors in young people. *Crisis*. 2013;34:223-232.
3. Mortier P, Auerbach RP, Alonso J, et al. Suicidal thoughts and behaviors among college students and same-aged peers: results from the World Health Organization World Mental Health Surveys. *Soc Psychiatry Psychiatr Epidemiol*. 2018;53:279-288.
4. Mortier P, Demyttenaere K, Auerbach R, et al. First onset of suicidal thoughts and behaviours in college. *J Affect Disord*. 2017;207:291-299.
5. Rotenstein L, Ramos M, Torre M. Prevalence of depression, depressive symptoms, and suicidal ideation among medical students: A systematic review and meta-analysis. *JAMA*. 2016;316:2214-2236.
6. Henning M, Krägeloh C, Hawken S, et al. The quality of life of medical students studying in New Zealand: A comparison with nonmedical students and a general population reference group. *Teach Learn Med*. 2012;24:334-340.
7. Ibrahim M, Abdelreheem M. Prevalence of anxiety and depression among medical and pharmaceutical students in Alexandria University. *Alexandria J Med*. 2015;51:167-173.
8. Jönsson M, Ojehagen A. Medical students experience more stress compared with other students. *Lakartidningen*. 2006;103:840-843.
9. Aktekin M, Karaman T, Senol YY, et al. Anxiety, depression and stressful life events among medical students: a prospective study in Antalya, Turkey. *Medical Education*. 2001;35:12-17.
10. Aboalshamat K, Hou X-Y, Strodl E. Psychological well-being status among medical and dental students in Makkah, Saudi Arabia: A cross-sectional study. *Medical Teacher*. 2015;37(sup1):S75-S81.
11. Dias Pereira M, Barbosa M. Teaching strategies for coping with stress - the perceptions of medical students. *BMC Med Educ*. 2013;13:50.
12. Fink-Miller E. Provocative work experiences predict the acquired capability of suicide in physicians. *Psychiatry Res*. 2015;229:143-147.
13. Dyrbye L, Shanafelt T. A narrative review on burnout experienced by medical students and residents. *Med Edu*. 2015;50:132-149.
14. Shah M, Hasan S, Malik S, et al. Perceived stress, sources and severity of stress among medical undergraduates in a Pakistani Medical School. *BMC Med Educ*. 2010;10:2.
15. Sreeramareddy C, Shankar P, Binu V, et al. Psychological morbidity, sources of stress and coping strategies among undergraduate medical students of Nepal. *BMC Med Educ*. 2007;7:26.
16. Matheson K, Barrett T, Ladine J, et al. Experiences of psychological distress and sources of stress and support during medical training: A survey of medical students. *Acad Med*. 2016;40:63-68.
17. Gazzaz Z, Baig M, Al Alhendi B, et al. Perceived stress, reasons for and sources of stress among medical students at Rabigh Medical College, King Abdulaziz University, Jeddah, Saudi Arabia. *BMC Med Educ*. 2018;18:29.
18. Spring L, Robillard D, Gehlbach L, et al. Impact of pass/fail grading on medical students' well-being and academic outcomes. *Med Edu*. 2011;45:867-877.
19. Botelho F, Bergamo I, Oliveira M, et al. Stress level assessment and medical school program correlations between learning styles and teaching methodologies. *Med Ed Publish*. 2017;6:22.
20. Radcliffe C, Lester H. Perceived stress during undergraduate medical training: A qualitative study. *Med Edu*. 2003;37:32-38.
21. Helmers K, Danoff D, Steinert Y, et al. Stress and depressed mood in medical students, law students, and graduate students at McGill University. *Acad Med*. 1997;72:708-714.
22. Williams D. The future of medical education: Flipping the classroom and education technology. *Ochsner J*. 2016;16:14-15.
23. Shapiro S, Shapiro D, Schwartz G. Stress management in medical education: A review of the literature. *Acad Med*. 2000;75:748-759.

24. Robinson J, Cleave A, Bailey E. Suicide prevention in educational settings: A review. *Australas Psychiatry*. 2018;26:132-140.
25. Tyssen R, Vaglum P, Grønvold N, et al. Suicidal ideation among medical students and young physicians: A nationwide and prospective study of prevalence and predictors. *J Affect Disord*. 2001;64:69-79.
26. Dyrbye L, Thomas M, Massie Jr. F, et al. Burnout and suicidal ideation among U.S. medical students. *Ann Intern Med*. 2008;149:334-341.
27. Higgins J, Altman D, Gøtzsche P, et al. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. *BMJ*. 2011;343:d5928.
28. Sterne J, Hernán M, Reeves B, et al. ROBINS-I: A tool for assessing risk of bias in non-randomised studies of interventions. *BMJ*. 2016;355:i4919.
29. The Nordic Cochrane Centre Review Manager (RevMan), version 5.3. 5.3 ed: The Nordic Cochrane Centre, The Cochrane Collaboration; 2014.
30. Thompson D, Geobert D, Takeshita J. A program for reducing depressive symptoms and suicidal ideation in medical students. *Acad Med*. 2010;85:1635-1639.
31. Bond AM, HF, Lemaster C, Shaw S, et al. Embodied health: The effects of a mind-body course for medical students. *Med Ed Online*. 2013;18:20699.
32. Chen A, Kumar A, Haramati A. The effect of a Mind-Body-Medicine course on medical student empathy: A pilot study. *Med Ed Online*. 2016;21:e31196.
33. de Vibe M, Solhaug I, Tyssen R, et al. Mindfulness training for stress management: A randomised controlled study of medical and psychology students. *BMC Med Educ*. 2013;13:107.
34. Dutton M, Arun P, Talley J, et al. Mind-body skills training for improving emotional well-being in medical students. *Explore*. 2013;9:328.
35. Finkelstein C, Brownstein A, Scott C, et al. Anxiety and stress reduction in medical education: An intervention. *Med Educat*. 2007;41:258-264.
36. Greeson J, Toohey M, Pearce M. An adapted, four-week mind-body skills group for medical students: Reducing stress, increasing mindfulness, and enhancing self-care. *Explore*. 2015;11:186-192.
37. Hassed C, de Lisle S, Sullivan G, et al. Enhancing the health of medical students: Outcomes of an integrated mindfulness and lifestyle program. *Adv in Health Sci Educ*. 2009;14:387-389.
38. Kraemer K, Luberto C, Wasson R, et al. Does mind-body skills training help medical students to more effectively tolerate distressing emotions? *Integrative Medical Research*. 2015;4:83-84.
39. Moir F, Henning M, Hassed C, et al. A peer-support and mindfulness program to improve the mental health of medical students. *Teach Learn Med*. 2016;28(293-302).
40. Rosenzweig S, Reibel D, Greeson J, et al. Mindfulness-based stress reduction lowers psychological distress in medical students. *Teach Learn Med*. 2003;15:88-92.
41. Shapiro S, Schwartz G, Bonner G. Effects of mindfulness-based stress reduction on medical and premedical students. *J Behav Med*. 1998;21:581-599.
42. Warnecke E, Quinn S, Ogden K, et al. A randomised controlled trial of the effects of mindfulness practice on medical student stress levels. *Med Ed*. 2011;45:381-388.
43. Danielwitz M, Bradwejn J, Koszycki D. A pilot feasibility study of a peer-led mindfulness program for medical students. *Can Med Educ J*. 2016;7:e31-37.
44. Phang C, Mukhtar F, Ibrahim N, et al. Effects of a brief mindfulness-based intervention program for stress management among medical students: The Mindful-Gym randomized controlled trial. *Advances in Health Sciences Education* 2015;20:1115-1134.
45. Garneau K, Hutchinson T, Zhao Q, et al. Cultivating person-centered medicine in future physicians. *European Journal for Person Centered Healthcare*. 2013;1:468-477.
46. Wild K, Scholz M, Ropohl A, et al. Strategies against burnout and anxiety in medical education - implementation and evaluation of a new course on relaxation techniques (*Relacs*) for medical students. *PLoS One*. 2014;9:e114967.

47. Kötter T, Pohontsch N, Voltmer E. Stressors and starting points for health-promoting interventions in medical school from the students' perspective: A qualitative study. *Perspect Med Educ*. 2015;4:128-135.
48. Holm M, Tyssen R, Stordal K, et al. Self-development groups reduce medical school stress: A controlled intervention study. *BMC Med Educ*. 2010;10:23.
49. McGrady A, Brennan J, Lynch D, et al. A wellness program for first year medical students. *Appl Psychophysiol Biofeedback*. 2012;27:253-260.
50. Holtzworth-Munroe A, Munroe M, Smith R. Effects of a stress-management training program on first- and second-year medical students. *Acad Med*. 1985;60:417-419.
51. Kelly J, Bradlyn A, Dubbert P, et al. Stress management training in medical school. *J Med Educ*. 1982;57:91-99.
52. Mitchie S, Sandhu S. Stress management for clinical medical students. *Med Educ*. 1994;28:528-533.
53. Bughi S, Sumcad J, Bughi S. Effect of brief behavioral intervention program in managing stress in medical students from two Southern California universities. *Med Edu Online*. 2006;11:4593.
54. Yusoff M, Esa A. A DEAL-based intervention for the reduction of depression, denial, self-blame and academic stress: A randomized controlled trial. *Journal of the Taibah University Medical Sciences*. 2015;10:82-92.
55. Melo-Carrillo A, Van Oudenhove L, Lopez-Avila A. Depressive symptoms among Mexican medical students: High prevalence and the effect of a group psychoeducation intervention. *J Affect Disord*. 2102;136:1098-1103.
56. Ball S, Bax A. Self-care in medical education: Effectiveness of health-habits interventions for first-year medical students. *Acad Med*. 2002;77:911-917.
57. Whitehouse W, Dinges D, Orne E, et al. Psychosocial and immune effects of self-hypnosis training for stress management throughout the first semester of medical school. *Psychosom Med*. 1996;58:249-263.
58. Velayudhan A, Gayatrivedi S, Bhattacharjee R. Efficacy of behavioral intervention in reducing anxiety and depression among medical students. *Ind Psychiatry*. 2010;19:41-46.
59. Bansal R, Gupta M, Agarwal B, et al. Impact of short term yoga intervention on mental well being of medical students posted in community medicine: A pilot study. *Indian J Comm Med*. 2013;38:105-108.
60. Simard A-A. Impact of a short yoga intervention on medical students' health: A pilot study. *Med Teach*. 2009;31:10.
61. Gallagher T, Munro J, Kahl L. Development and implementation of a clerkship counseling hotline. *Teach Learn Med*. 2005;17:80-84.
62. Kiecolt-Glaser J, Belury M, Andridge R, et al. Omega-3 supplementation lowers inflammation and anxiety in medical students: A randomized controlled trial. *Brain Behav Immun*. 2011;25:1725-1734.
63. Mercer A, Warson E, Zhao J. Visual journaling: An intervention to influence stress, anxiety and affect levels in medical students. *The Arts in Psychotherapy*. 2010;37:143-148.
64. Al-Faris E, Naeem N, Irfan F, et al. Student centered curricular elements are associated with a healthier educational environment and lower depressive symptoms in medical students. *BMC Medical Education*. 2014;14:192.
65. Camp D, Hollingsworth M, Zaccaro D, et al. Does a problem-based learning curriculum affect depression in medical students? *Acad Med*. 1994;21:e31996.
66. Slavin S, Shoss M, Broom M. A program to prevent burnout, depression, and anxiety in first-year pediatric residents. *Acad Pediatr*. 2017;17:456-458.
67. Zuardi A, De Guerra Prota F, CM D-B. Reduction of the anxiety of medical students after curricular reform [Redução da ansiedade de estudantes de medicina após reforma curricular]. *Revista Brasileira de Psiquiatria*. 2008;30:136-138.

68. Moffat K, McConnachie A, Ross S, et al. First year medical student stress and coping in a problem-based learning medical curriculum. *Med Ed*. 2004;38:482-491.
69. Schwenk T, Davis L, Wimsatt L. Depression, stigma, and suicidal ideation in medical students. *JAMA*. 2010;304:1181-1190.
70. Moutinho I, de Castro Pecci Maddalena N, Lucchetti A, et al. Depression, stress and anxiety in medical students: A cross-sectional comparison between students from different semesters. *Rev Assoc Med Bras*. 2017;63:21-28.
71. Ludwig A, Burton W, Weingarten J, et al. Depression and stress amongst undergraduate medical students. *BMC Med Educ*. 2015;15:141.
72. Dyrbye L, Thomas M, Shanafelt T. Systematic review of depression, anxiety, and other indicators of psychological distress among US and Canadian medical students. *Acad Med*. 2006;81:354-373.
73. Baldassin S, Alves T, de Andrade AG, et al. The characteristics of depressive symptoms in medical students during medical education and training: a cross-sectional study. *BMC Medical Education*. 2008;8(1):60.
74. Casey D, Thomas S, Hocking D, et al. Graduate-entry medical students: Older and wiser but not less distressed. *Australas Psychiatry*. 2015;24:88-92.
75. Clifford A, Doran C, Tsey K. A systematic review of suicide prevention interventions targeting indigenous peoples in Australia, United States, Canada, and New Zealand. *BMC Public Health*. 2013;13:463.
76. Card A. Physician burnout: Resilience training is only part of the solution. *Ann Fam Med*. 2018;16:267-270.

FIGURES

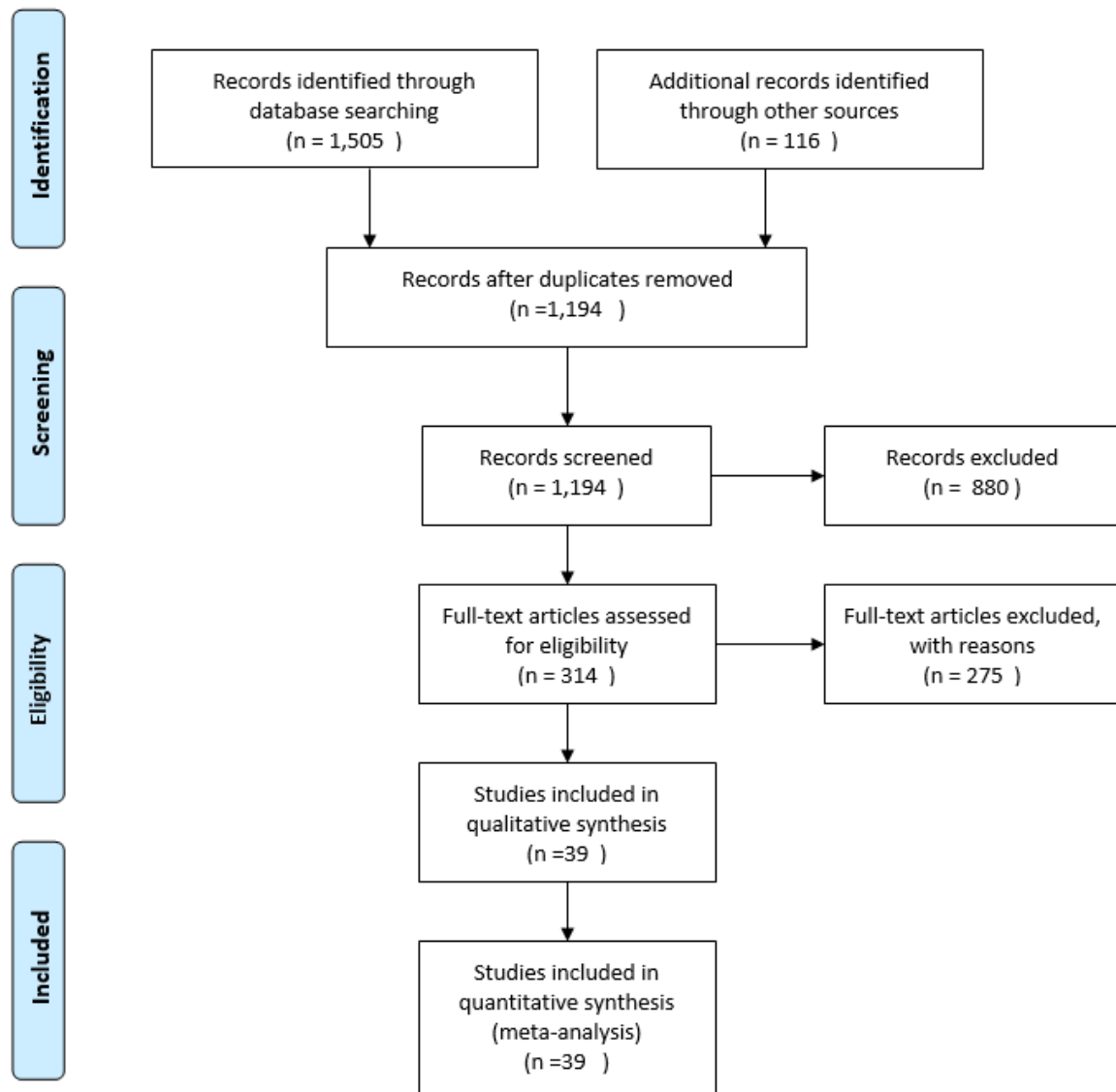


Figure 1. PRISMA flow diagram.

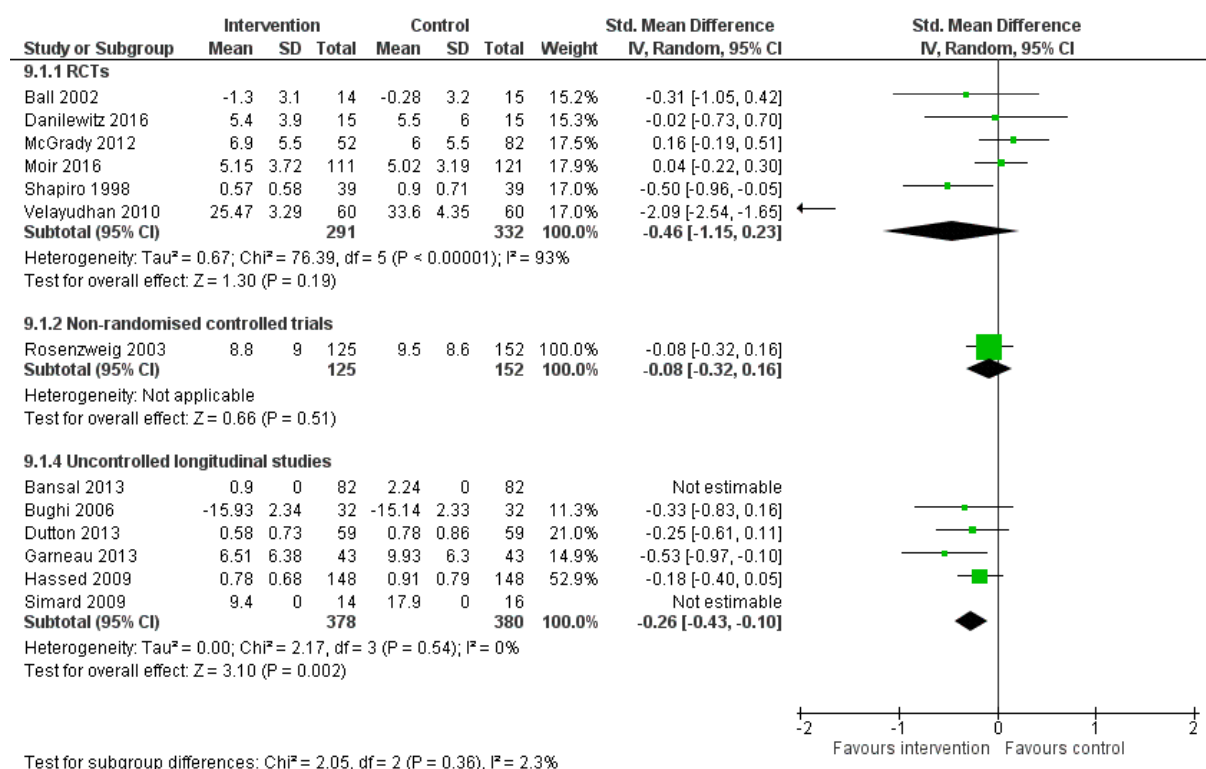


Figure 2: Random effects standardised mean difference (SMD), and accompanying 95% confidence interval (CI), on self-reported depression scores at the post-intervention assessment.

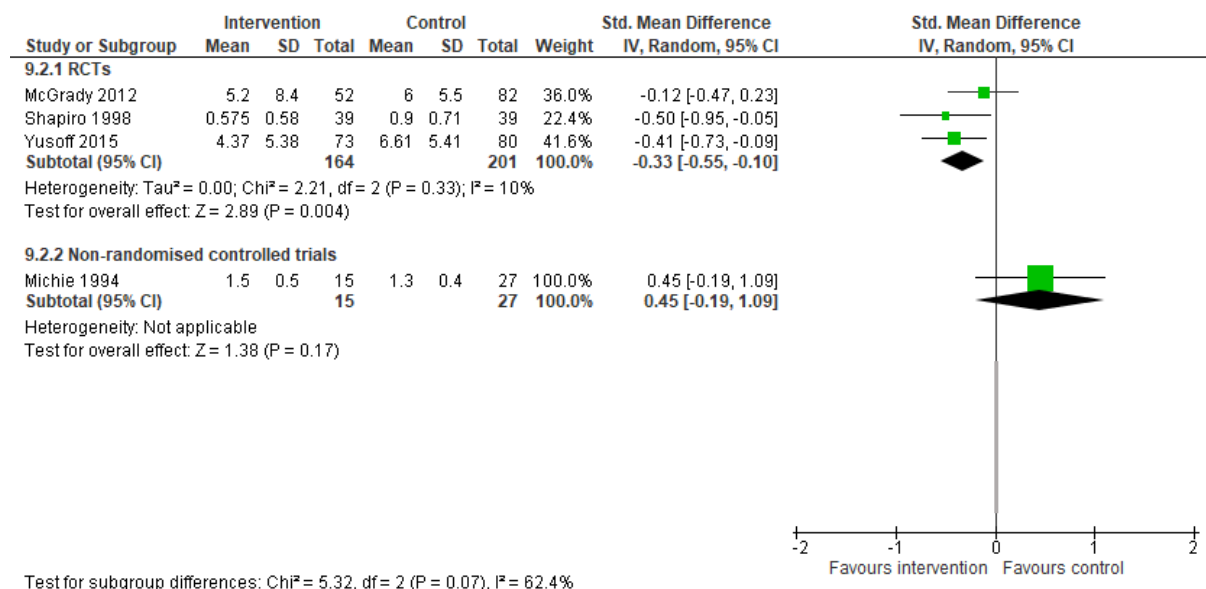


Figure 3: Random effects standardised mean difference (SMD), and accompanying 95% confidence interval (CI), on self-reported depression scores at the longest follow-up assessment.

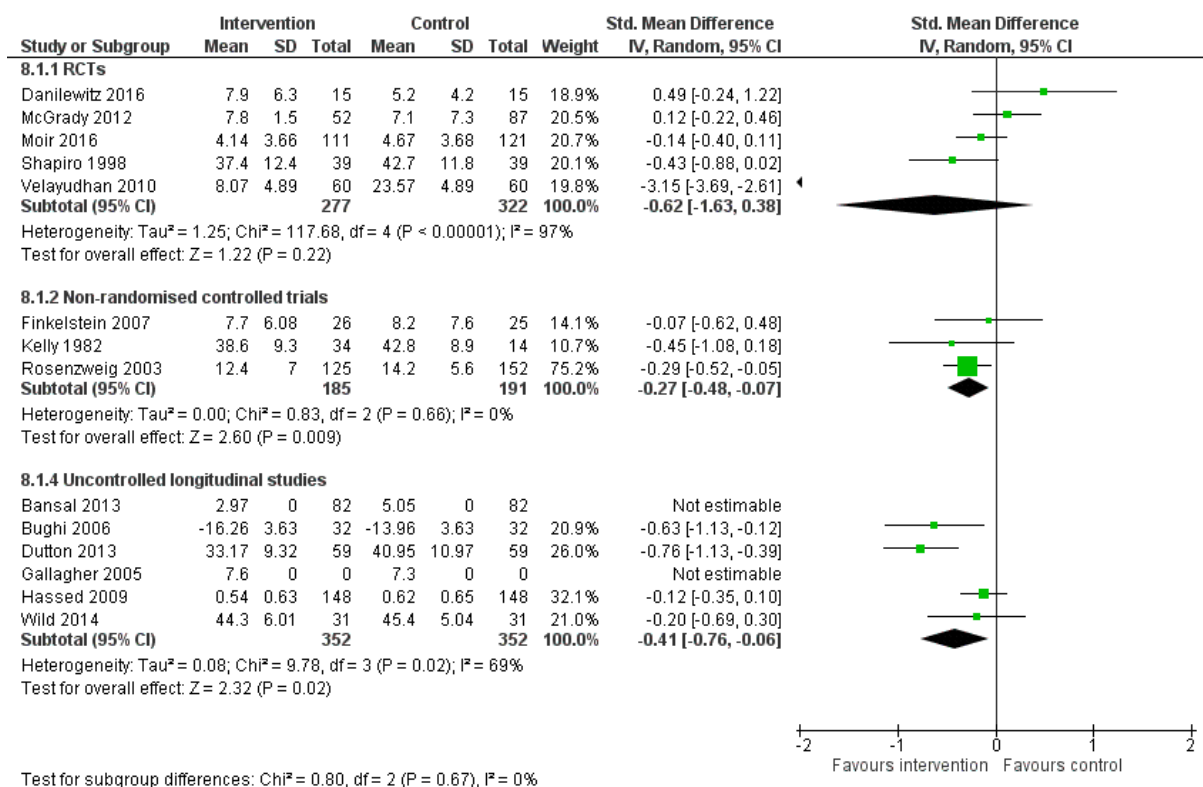


Figure 4: Random effects standardised mean difference (SMD), and accompanying 95% confidence interval (CI), on self-reported anxiety scores at the post-intervention assessment.

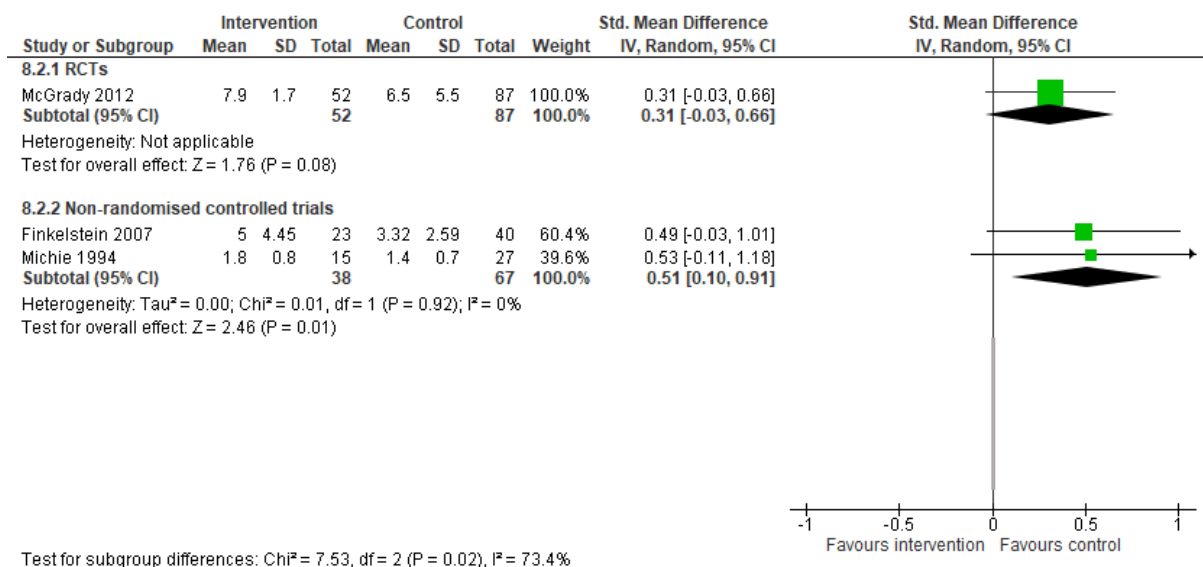


Figure 5: Random effects standard mean difference (SMD), and accompanying 95% confidence interval (CI), on self-reported anxiety scores at the final follow-up assessment.

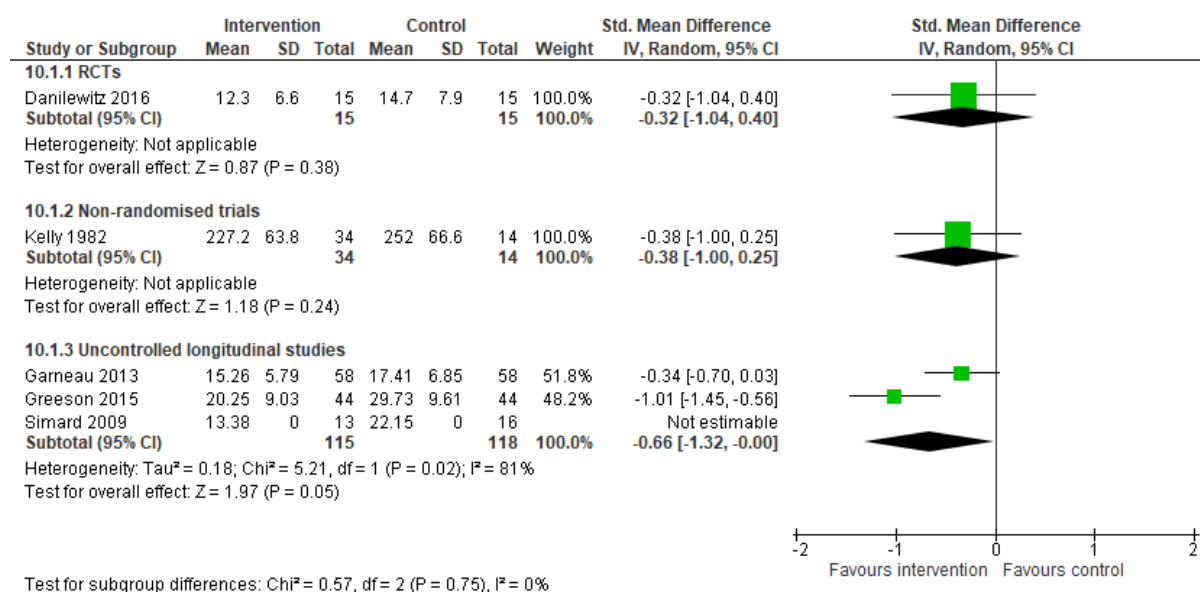


Figure 6: Random effects standardised mean difference (SMD), and accompanying 95% confidence interval (CI), on self-reported stress scores at the post-intervention assessment.

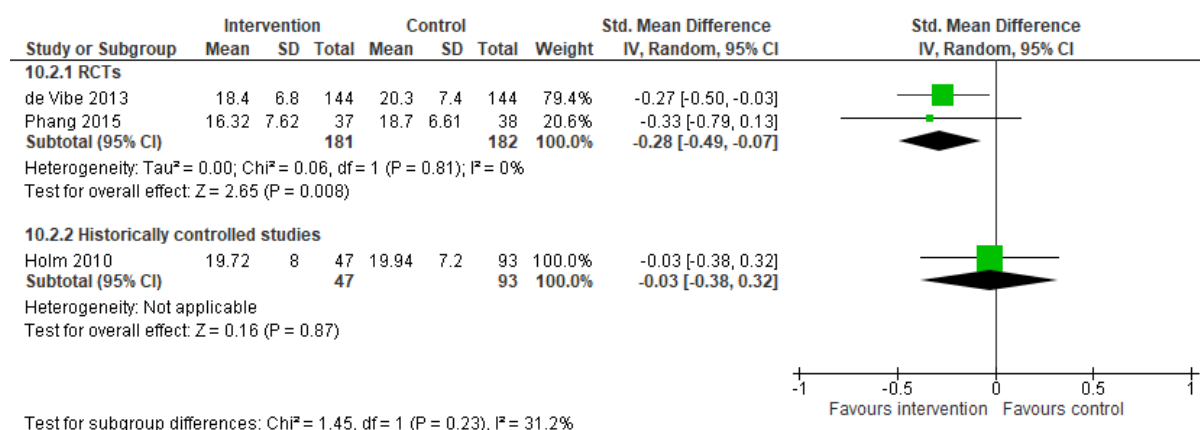


Figure 7: Random effects standardised mean difference (SMD), and accompanying 95% confidence interval (CI), on self-reported stress scores at the final follow-up assessment.

Table 1. Methodological characteristics of the 39 studies included in this review by study design.

Author	Year	Trial Registration Number	Country	Methods	Participants	Intervention	Control	Duration of Intervention	Outcomes assessed
Randomised Controlled Trials (RCTs)									
Ball	2002	N/A	USA	Randomised controlled trial comparing a single session of a psycho-educational intervention with no treatment for the prevention of depression in medical students in their first year at one university.	A total of 29 young adult (mean age: 24.0 years; SD: 3.4 years) male and female (40.7% female) undergraduate medical students in their first year at one university.	A single session (approximately 1.5 hours) of a self-awareness and self-care intervention focusing on: providing written psychoeducation about depression, sleepiness, and alcohol use.	Information on content of the control condition not clearly reported.	Not clearly reported	Anxiety: not assessed. Burnout: not assessed. Depression: Beck Depression Inventory (BDI-II). Stress: not assessed. Suicidality: not assessed. Other outcomes: alcohol use problems (AUDIT), quality of life (Medical Education Quality of Life Questionnaire), sleep problems (Epworth Sleepiness Scale), and physical health (Health Habits Survey).
Danilewitz	2016	N/A	Canada	Randomised controlled trial comparing an eight-week, adapted version of a manualised mindfulness-based stress reduction program with wait-list for the prevention of stress in medical students in their first and second years at one university.	A total of 30 young adult (mean age: not clearly reported) male and female (73.3% female) undergraduate medical students in their first year at one university.	Eight sessions (1.5 hours) of a manualised mindfulness-based stress reduction program consisting of: body scan, mindfulness, breathing exercises, stress management, yoga, loving kindness, meditation, and mindful communication. Students also received weekly homework meditation exercises. Sessions were co-facilitated by a trained medical student peer worker with a psychologist with training in mindfulness meditation.	No intervention.	Not clearly reported, assume eight weeks	Anxiety: Depression, Anxiety, Stress Scale (DASS). Burnout: not assessed. Depression: DASS. Stress: DASS. Suicidality: not assessed. Other outcomes: altruistic behaviours (Adapted Altruism Scale), empathy (Jefferson Scale of Physician Empathy-Student Version), mindfulness skills (Five Facets of Mindfulness Questionnaire), satisfaction with the program (idiosyncratic five-point scale ranging from disagree [1] to agree [5]), and self-compassion (Self-Compassion Scale).
de Vibe	2013	NCT00892138	Norway	Parallel group randomised controlled trial comparing a seven-week course of a manualised mindfulness-based stress reduction program with no treatment for the prevention of burnout and stress in medical and psychology students undertaking their second or third years at two universities.	A total of 288 young adult (mean age: 23.0, SD: not reported) male and female (76.0% were female) medical and psychology students in their second and third years at two universities. No specific exclusion criteria were reported.	Consisted of seven weekly sessions (approximately 1.5 hours; session seven was a six hour, day-long session), of a manualised mindfulness-based stress reduction program consisting of: mindfulness, didactic teaching on mindfulness, stress management, and mindful communication, and group sessions to facilitate reflection. Sessions were facilitated by trained instructors (three male, three female). Participants also received weekly homework exercises to consolidate skills learned.	Consisted of standard university courses with no intervention	7 Weeks	Anxiety: not assessed. Burnout: Maslach Burnout Inventory. Depression: not assessed. Stress: Perceived Medical School Stress Scale. Suicidality: not assessed. Other outcomes: distress (General Health Questionnaire, 12 item), well being (Subjective Well Being Scale, 4 item version), mindfulness (Five Facet Mindfulness Questionnaire), and compliance (idiosyncratic scale based on self-reported home-based mindfulness practice)

Holtzworth-Munroe	1985	N/A	USA	Parallel group randomised controlled trial comparing a six sessions of a manualised group-based stress management with no treatment for the prevention of stress in first and second year medical students at one university.	A total of 40 young adult (mean age: not reported) male and female (proportion female not reported) undergraduate medical students in their first and second years at one university. No specific exclusion criteria were reported.	Consisted of six, hour long sessions of a manualised group-based stress management program, consisting of: cognitive restructuring, progressive muscle relaxation, and meditation. The session was facilitated by a doctoral student in clinical psychology	Consisted of standard university courses with no intervention.	6 Weeks	Anxiety: Spielberger Trait Anxiety Inventory. Burnout: not assessed. Depression: not assessed. Stress: not assessed. Suicidality: not assessed. Other outcomes: awareness of stress and coping ability (idiosyncratic scale).
Kiecolt-Glaser	2011	N/A	USA	Parallel group, double-blind, placebo controlled, randomised controlled trial comparing daily omega three fatty acid supplementation with placebo for the prevention of anxiety in first and second year medical students.	A total of 68 young adult (mean age: 23.6, SD: 1.9 years) male and female (44.1% were female) medical students in their first or second years at one university. Exclusion criteria were: high fish intake, fish oil or flaxseed supplements, smoking, alcohol or drug use, any chronic illness with an inflammatory or endocrine component, lipid-altering drugs, beta blockers, steroids, ACE-inhibitors, regular use of non-steroidal anti-inflammatories, and use of psychoactive drugs or mood altering medications.	Capsules containing 2.496 grams of an omega three fatty acid supplement. Each capsule contained 2085mg of eicosapentaenoic acid and 348mg of docosahexaenoic acid. Participants were instructed to take one capsule per day.	Capsules containing a mixture palm, olive, soy, canola, and coco butter oils. Participants were instructed to take one capsule per day.	12 Weeks	Anxiety: Beck Anxiety Inventory (BAI). Burnout: not assessed. Depression: Center for Epidemiological Studies Depression scale (CES-D). Stress: not assessed. Suicidality: not assessed.
McGrady	2012	N/A	USA	Parallel group randomised controlled trial comparing a four-month course of stress management and relaxation program with wait-list control for the prevention of anxiety and depression in medical students in their first year.	A total of 449 young adult (mean age: 23.4, SD: not provided) male and female (51.5% were female) medical students in their first year at one university. No specific exclusion criteria were reported.	Consisted of eight bi-monthly sessions (approximately 45 minutes) of a stress management program facilitated by an experiencing psychologist, counsellor, or physician. Program components focused on deep breathing, progressive relaxation, guided imagery, cognitive restructuring (termed 'survival thinking' in this trial), mindfulness, meditation, nutrition, coping, managing fatigue and anxiety, and balancing study and life.	No specific intervention was received.	4 Months	Anxiety: BAI. Burnout: not assessed. Depression: BDI-II. Stress: not assessed. Suicidality: not assessed. Other outcomes: social adjustment (Social Readjustment Rating Scale-Revised [SRRS-R]), and an idiosyncratic scale developed to assess frequency of acute illness.
Moir	2016	N/A	New Zealand	Parallel group randomised controlled trial comparing a six-month course of weekly mindfulness sessions delivered by trained peer leaders with treatment as usual for the prevention of depression	A total of 275 young adult (mean age: 20.9, SD: not provided) male and female (53.0% were female) undergraduate medical students in years 2 or 3 at one university. No specific	Consisted of weekly sessions of mindfulness based on the manualised Oxford University Peer Support Program with specific sessions on reflective listening, barriers and enables of help-seeking behaviour, enabling decision-making,	Consisted of treatment as usual, including usual health and mental health resources (e.g., the university counselling service and student medical clinic).	6 Months	Anxiety: Generalized Anxiety Disorder Questionnaire (GAD-7). Burnout: not assessed. Depression: PHQ-9. Stress: not assessed. Suicidality: not assessed. Other outcomes: quality of life (Linear Analogue Self-Assessment), resilience (Wagnild Resilience

				and anxiety in undergraduate medical students (year 2 and 3).	exclusion criteria were reported.	values and judgements, identifying and labelling feelings, cultural competency, safety planning, developing limit-setting boundaries, assertiveness, crisis planning, suicide awareness, prevention, resources, and referral options. Two social events were also organised over the course of the program.	Participants in the control group were asked not to undertake mindfulness or two attend the two social events, however, they were not prevented from doing so.		Scale), academic self-concept (Perceived Competence Scale), academic motivation (Motivated Strategies for Learning Questionnaire)
Phang	2015	N/A	Malaysia	Parallel group randomised controlled trial comparing an adapted five-week mindfulness-based stress reduction program with wait-list for the prevention of stress in medical students in their first, second, or third years at one university.	A total of 75 young adult (mean age: 21.0; SD: 1.1 years) male and female (76.0% were female) undergraduate medical students in their first, second, or third years at one university. No specific exclusion criteria were reported.	Consisted of an adapted five-week program of a manualised mindfulness-based stress reduction program consisting of five weekly sessions (two hours) of: gratitude and cultivation of loving-kindness, stress reduction, cultivating the ability to pay attention to the present moment, and progressive muscle relaxation exercises. Sessions were facilitated by an experienced psychiatrist with more than 10 years' experience.	Participants randomised to the control group received the intervention materials in full on DVD at the conclusion of the six month follow-up period.	5 Weeks	Anxiety: not assessed. Burnout: not assessed. Depression: not assessed. Stress: Perceived Stress Scale (PSS). Suicidality: not assessed. Other outcomes: compliance (idiosyncratic five-point Likert scale ranging from none at all [1] to almost every day [5]), general psychiatric symptomatology (General Health Questionnaire), mindfulness skills (Mindful Attention Awareness Scale), self-efficacy (General Self-Efficacy Scale).
Shapiro	1998	N/A	USA	Parallel group randomised controlled trial comparing an eight-week course of mindfulness with wait-list for the prevention of stress in medical and premedical students (years 1 and 2).	A total of 73 young adult (mean age: not provided, SD: not provided) male and female (56.2% were female) medical or premedical students in years 1 or 2 at one university. No specific exclusion criteria were reported.	Consisted of seven sessions (approximately 2.5 hours) of a mindfulness program based on the manualised Stress Reduction and Relaxation Program with specific sessions on meditation, attention on bodily sensations, hatha yoga, loving kindness, and forgiveness. Additional exercises in mindful listening, empathy, social support, as well as the completion of daily journals were also added.	No specific intervention was received.	8 Weeks	Anxiety: State-Trait Anxiety Inventory (STAI). Depression: sub-scale 4 of the SCL-90-R. Stress: not assessed. Suicidality: not assessed. Other outcomes: empathy (Empathy Construct Rating Scale [ECRS]), psychological distress (Hopkins Symptom Checklist-90-Revised [SCL-90-R]), spirituality (Index of Core Spiritual Experiences-INSPIRIT), and compliance with meditation practice (from daily diary entries).
Velayudhan	2010	N/A	India	Parallel group randomised controlled trial comparing a course of counselling and relaxation (number of sessions, duration of sessions, and length of intervention period not reported) with no treatment for the prevention of stress in undergraduate medical	A total of 120 young adult (mean age: not reported) male and female (50.0% were female) undergraduate medical students at one private medical college. No specific exclusion criteria were reported.	Consisted of a course of counselling and relaxation. The number of sessions, duration of sessions, and length of the intervention period were not reported.	No specific intervention was received.	Not clearly reported	Anxiety: BAI. Burnout: not assessed. Depression: BDI-II Stress: not assessed. Suicidality: not assessed. Other outcomes: not assessed.

				students at one private medical college.					
Warnecke	2011	N/A	Australia	Parallel group randomised controlled trial comparing an eight-week CD-based, guided mindfulness program with wait-list for the prevention of stress in medical students undertaking their final two years at one university.	A total of 66 young adult (mean age: 23.9, SD: 3.2 years) male and female (64.6% were female) undergraduate medical students in their final two years at one university. No specific exclusion criteria were reported.	Consisted of an eight-week CD-based guided meditation program with each session lasting approximately 30 minutes. Participants were also required keep a daily diary to enable monitoring of adherence.	No specific treatment was received.	8 Weeks	Anxiety: DASS. Burnout: not assessed. Depression: DASS Stress: DASS and PSS. Suicidality: not assessed. Other outcomes: not assessed.
Whitehouse	1996	N/A	USA	Parallel group randomised controlled trial comparing a 19-week self-hypnosis and relaxation program with no treatment for the prevention of stress in first-year medical students.	A total of 35 young adult (mean age: not reported) male and female (60.0% were female) medical students in years 1 at one university. No specific exclusion criteria were reported.	consisted of 14 sessions (approximately 90 minutes) of self-hypnosis facilitated by trained senior psychiatrists with experience in the clinical use of hypnosis and relaxation techniques. Session one consisted of an assessment of each participant's hypnotic ability, whilst sessions two to 14 focused on practicing skills. Participants were also encouraged to engage in self-hypnosis for at least 15 minutes per day individually, and completed daily diaries.	No specific intervention was received. However, participants in this group were required to complete daily diaries enquiring about extent and quality of sleep, mood, use of medications, and any problems experienced.	19 Weeks	Anxiety: BSI. Burnout: not assessed. Depression: BSI. Stress: not assessed. Suicidality: not assessed. Other outcomes: various immunological assays as well as somatization, obsessive-compulsive, interpersonal sensitivity, hostility, phobic anxiety, paranoia, psychoticism, general severity, positive symptoms, and psychological distress (all measured by the BSI).
Yusoff	2015	N/A	Malaysia	Parallel group randomised controlled trial comparing a four-hour session of a psychoeducational and problem-oriented stress management program (DEAL) with wait-list for the prevention of stress in undergraduate medical students (years 1 to 5).	A total of 171 young adult (mean age: not reported) male and female (57.9% were female) undergraduate medical students in years 1 to 5 at one university. No specific exclusion criteria were reported.	Consisted of a single four-hour workshop of a psychoeducational and problem-oriented stress management program (DEAL). Section one (one hour) focused on psychoeducation on stress, stressors, and coping mechanisms of relevance to medical students. Session two (one hour) focused on learning problem-solving techniques and coping strategies to manage stress. Session three (one hour) focused on group-based exercises to practice these strategies, and session four (one hour) focused on sharing experiences and concluding the program.	No specific intervention was received.	4 Hours	Anxiety: not assessed. Burnout: not assessed. Depression: BDI-II. Stress: total scores on the MSSQ-20, as well as scores on six domains: (1) Academic-Related Stressors; (2) Intrapersonal and Interpersonal Stressors; (3) Teaching and Learning-Related Stressors; (4) Social-Related Stressors; (5) Drive and Desire-Related Stressors, and; (6) Group Activities-Related Stressors. Suicidality: not assessed. Other outcomes: not assessed.

Non RCTs									
Chen	2016	N/A	USA	Non-randomised controlled trial comparing an 11-week course of mind-body skills training with no treatment for the prevention of stress in medical students in their first year.	A total of 20 young adult (mean age: not reported) male and female (proportion female not reported) medical students in their first year at one university. No specific exclusion criteria were reported.	Consisted of 11 sessions of a mind-body skills course. Core components included: meditation, guided imagery, and journal writing facilitated by two trained facilitators. The duration of these sessions was not reported.	No specific intervention was received.	No specific information reported	Anxiety: not assessed. Burnout: not assessed. Depression: PHQ-9. Stress: PSS. Suicidality: not assessed. Other outcomes: empathy (Jefferson Scale of Physician Empathy-Student Version [JSPE-S])
Finkelstein	2007	N/A	USA	Non-randomised controlled trial comparing a 10-week course of mind-body skills training with no treatment for the prevention of anxiety and stress in medical students in their first year.	A total of 76 young adult (mean age: 25.0, SD: 2.3 years) male and female (51.3% were female) medical students in their first year at one university. No specific exclusion criteria were reported.	Consisted of 10 weekly sessions (approximately two hours) of a manualised mind-body skills course. Core components included: psychoeducation on stress response, meditation, imagery, advice on exercise and nutrition, and spirituality using both a small- and large-group format.	No specific intervention was received.	10 Weeks	Anxiety: subscale from the SCL-90. Burnout: not assessed. Depression: two-item Depression Index (DI-2). Stress: Perceived Stress of Medical School (PSMS). Suicidality: not assessed. Other outcomes: Profile of Mood States (POMS).
Kelly	1982	N/A	USA	Non-randomised controlled trial comparing a six session program of stress management training with wait-list for the prevention of stress in medical students in their first, second or third years.	A total of 48 young adult (mean age: not reported) male and female (33.0% were female) medical students in their first, second, or third years at one university. A minority of participants (20.0%) were residents and nurses. No specific exclusion criteria were reported.	six sessions (of between 60-90 minutes) of a stress management training program consisting of: didactic lectures on stress reduction techniques, group-based discussions, relaxation techniques, priority-setting, schedule-planning, focusing on engaging in leisure activities, exercise, cognitive modification skills training, and homework assignments to practice the stress reduction technique introduced.	A single, "almost identical" (p. 95) seminar (duration: not specified) of stress management training was received following the conclusion of the post-test period.	3 Weeks	Anxiety: Spielberger State-Trait Anxiety Inventory. Burnout: not assessed. Depression: Zung Self-Rating Depression Scale, using a cut off score of 60 or greater, indicating moderate to severe depression. Stress: Jenkins Activity Schedule, Type A subscale. Suicidality: not assessed. Other outcomes: compliance (daily activity log), knowledge about stress (Stress Knowledge Inventory, 26 item), situations that cause the most stress (idiosyncratic scale ranging from zero [not stressful] to 100 [extremely stressful]).
Kraemer	2015	N/A	USA	Non-randomised controlled trial comparing an 11-week course of mind-body skills training with no treatment for the prevention of stress in medical students.	A total of 22 young adult (mean age: 23.9 years; SD: not reported) male and female (68.2% were female) medical students in their first year at one university. No specific exclusion criteria were reported.	Consisted of 11 weekly sessions (90 minutes) of a mind-body skills course.	No specific intervention was received.	11 Weeks	Anxiety: not assessed. Burnout: not assessed. Depression: not assessed. Stress: not assessed. Suicidality: not assessed. Other outcomes: distress (measure used not specified).
Michie	1994	N/A	USA	Non-randomised controlled trial comparing a three-week stress management program with wait-list for the prevention of stress in medical students in their first clinical year at one university.	A total of 302 young adult (mean age: not reported) male and female (proportion female not reported) medical students in their second year at one university. No specific exclusion criteria were reported.	Three weekly sessions (approximately 2 hours) of a stress management program consisting of: psychoeducation on models of stress, stress management techniques, work management skills, assertiveness and	no specific intervention was received. Instead, "[a]ttendees acted as their own 'waiting list' control group by asking those who had signed up for the course to	3 Weeks	Anxiety: Spielberger State-Trait Anxiety Inventory. Burnout: not assessed. Depression: not assessed. Stress: not assessed. Suicidality: not assessed.

						communication skills, relaxation techniques, cognitive approaches, overcoming barriers, and longer-term planning.	complete the evaluation questionnaire at two time points whilst they waited for their course" (p. 529).		
Rosenzweig	2003	N/A	USA	Non-randomised controlled trial comparing a 10-week course of mind-body skills training with attention placebo for the prevention of anxiety and stress in medical students in their second year.	A total of 302 young adult (mean age: not reported) male and female (proportion female not reported) medical students in their second year at one university. No specific exclusion criteria were reported.	Consisted of 10 weekly sessions (approximately 90 minutes) of a manualised mind-body skills course. Core components included: body scanning techniques, meditation, guided imagery exercises, breathing exercises, and Hatha Yoga delivered in a group-based format.	Sessions of complementary and alternative medicine. Core components included: didactic exercises, demonstrations, group exercises, and presentations. Both the number of sessions and the duration of these sessions was not reported.	10 Weeks	Anxiety: subscale from the POMS. Burnout: not assessed. Depression: subscale from the POMS. Stress: not assessed. Suicidality: not assessed. Other outcomes: anger, vigour, fatigue, and confusion subscales of the POMS as well as the overall POMS score.
Historically Controlled Studies									
Holm	2010	N/A	Norway	Historically controlled, retrospective study comparing 12 weekly group-based self-development program to prevent stress in undergraduate medical students at one university.	A total of 165 young adult (mean age: 23.6 years; SD: 3.4 years) male and female (59.4% were female) undergraduate medical students in their third year at one university. No specific exclusion criteria were reported.	12 weekly sessions (90 minute) of a group-based self-development program consisting of: identification of positive resources in the students' lives, building self-esteem, and personal insight. Sessions also focused on helping students to identify their typical patterns of relationships and how these may be restricting their ability to relate with others. Groups sessions were facilitated by qualified general practitioners and numbered between eight and 10 participants per group.	No specific intervention was received.	Not clearly reported, presume one year.	Anxiety: not assessed. Burnout: not assessed. Depression: not assessed. Stress: Perceived Medical School Stress (PMSS). Suicidality: not assessed. Other outcomes: general mental health functioning (SCL-5).
Melo-Carillo	2012	N/A	Mexico	Historically controlled study comparing a single session (duration not reported) of a psychoeducation intervention to prevent depression in undergraduate medical students at one university.	A total of 1958 young adult (mean age: not provided, SD: not provided) male and female (proportion female not reported) undergraduate medical students at one university teaching hospital. No specific exclusion criteria were reported.	A single, annual session (duration not reported) of psychoeducation focused on providing information on common mental disorders among medical students, information on diagnosis, complications, and treatment as well as the formation of a mental health	No specific intervention was received.	2 years	Anxiety: not assessed. Burnout: not assessed. Depression: BDI-II. Stress: not assessed. Suicidality: not assessed. Other outcomes: not assessed.

						support group, facilitated by six qualified psychiatrists (four male, two female), to provide confidential treatment to all students with mental health problems.			
Thompson	2010	N/A	USA	Historically controlled study comparing a package of interventions designed to prevent depression and suicidality in medical students at one university.	A total of 102 young adult (mean age: not provided, SD: not provided) male and female (proportion female was not reported) medical in years 1 to 3 at one university. No specific exclusion criteria were reported.	Consisted of one (30 minute) session of gate-keeper training for all faculty staff consisting of psychoeducation around student risk factors for depression and suicidality (e.g., sleep deprivation, isolation, and academic difficulties), symptoms of depression and suicidality, didactic exercises, and one-on-one coaching facilitated by psychiatric faculty staff. Students also received a well-being handbook which provided psychoeducation on common stressors, recognizing depression, advice on stress management, self-assessment exercises, along with a single, hour long, didactic discussion on managing stress during critical times of the year (e.g., examinations). All incoming first-year students could also participate in a well-being program with the following core components: discovering and nurturing wholeness, sharing grief and honouring loss, allowing awe in medicine, and the care of the soul.	No specific intervention was received	Not clearly specified, presume year-long.	Anxiety: not assessed. Burnout: not assessed. Depression: cut-off score of greater than 21 on the CES-D. Stress: not assessed. Suicidality: cut-off score of one or greater on the PRIME-MD. Other outcomes: not assessed.
Uncontrolled Studies									
Bansal	2013	N/A	India	Uncontrolled longitudinal study comparing a one-month program of a daily yoga program for the prevention of stress in medical undergraduate students at one university undertaking a clinical placement in community medicine.	A total of 82 young adult (mean age: not reported; age range: 18-32 years) male and female (55.6% were female) undergraduate medical students at one university undertaking a clinical placement in community medicine.	Daily sessions (45 minutes) of a yoga program consisting of: a series of seven postures (asana), followed by breathing exercises (pranayama), and meditation. Sessions were facilitated by a trained yoga instructor.	No specific information	1 Month	Anxiety: GHQ-28, subscale. Burnout: not assessed. Depression: GHQ-28, subscale. Stress: not assessed. Suicidality: not assessed. Other outcomes: general functioning (GHQ-28), satisfaction (qualitative comments), somatic symptoms (GHQ-28, subscale), and social dysfunction (GHQ-28, subscale).
Bond	2013	N/A	USA	Uncontrolled longitudinal study comparing an 11 session program of a	A total of 27 young adult (mean age: not reported) male and female (57.6% were	11 sessions (1.5 hours) of a manualised mind-body	No specific information	11 Weeks	Anxiety: not assessed. Burnout: not assessed. Depression: not assessed.

				manualised mind-body skills training intervention for the prevention of stress in medical students in their first and second years at one university.	female) medical students in their first and second years at one university.	skills program consisting of: deep breathing, meditation, yoga, stress management, and a 30-minute didactic lecture on neuroscience and mind-body medicine. Participants also received peer-reviewed psychoeducation on mind-body medicine and undertook weekly homework exercises.			Stress: Cohen's Perceived Stress Scale. Suicidality: not assessed. Other outcomes: empathy (Jefferson Scale of Physician Empathy), self-regulation abilities (Self-Regulation Questionnaire), self-compassion (Self-Compassion Scale).
Bughi	2006	N/A	USA	Uncontrolled longitudinal study of a single psychoeducational lecture on stress management for the prevention of stress in medical students from two universities undertaking a one-month clinical rotation at one Diabetes/Endocrine Service at a tertiary referral service.	A total of 32 young adult (mean age: not reported) male and female (proportion female not reported) medical students in their third and fourth years at two universities who were undertaking a one-month clinical rotation at one Diabetes/Endocrine Service at a tertiary referral service.	A single psychoeducational lecture (duration not specified) consisting of: a review of the epidemiology of the stress response, information on the psychological and medical complications of stress, stress inoculation, deep diaphragmatic breathing (prolonged expiration or deep yoga breathing), self-control relaxation, and walking meditation.	No specific information	Not clearly reported, described as brief	Anxiety: General Well-Being Scale, subscale (lower scores indicative of higher anxiety). Burnout: not assessed. Depression: General Well-Being Scale, subscale (lower scores indicative of higher depression). Stress: General Well-Being Scale subscale (lower scores indicative of higher stress). For this study, a cut-off value of 60 or lower was interpreted as indicative of those with severe stress. Suicidality: not assessed. Other outcomes: not assessed.
Dutton	2013	N/A	USA	Uncontrolled, prospective, longitudinal study comparing an 11 session program of a manualised mind-body skills training intervention for the prevention of stress in medical students in their first year at one university.	A total of 59 young adult (mean age: not reported) male and female (57.6% were female) medical students in their first year at one university.	11 sessions (duration not reported) of a manualised mind-body skills program consisting of: self-awareness, relaxation, meditation, guided imagery, and biofeedback skills.	No specific information	11 Weeks	Anxiety: State-Trait Anxiety Index. Burnout: not assessed. Depression: subscale, Brief Symptom Index. Stress: not assessed. Suicidality: not assessed. Other outcomes: distress (Brief Symptom Index), physical health (Brief Symptom Index), mindfulness skills (scale not clearly specified).
Gallagher	2005	N/A	USA	Uncontrolled longitudinal study comparing the establishment of a dedicated hotline for the prevention of anxiety in medical students in their third year at one university.	A total of 86 young adult (mean age: not reported) male and female (57.0% were female) medical students in their third year at one university.	A dedicated hotline, manned by a Masters-trained counsellor, designed to provide free, confidential advice to callers 24 hours a day, seven days a week. All students also received a laminated pocket card with further details and the hotline telephone number.	No specific information	1 Year	Anxiety: not assessed. Burnout: not assessed. Depression: not assessed. Stress: 10-point idiosyncratic scale ranging from one (least stressful year of life) to 10 (most stressful year of life). Suicidality: not assessed. Other outcomes: awareness of hotline (open-ended question), reassurance about existence of hotline (five-point idiosyncratic scale ranging from one [not at all reassuring] to five [very reassuring]), and importance of continuing the hotline (five-point idiosyncratic scale ranging from one [not at all important] to five [very important]).
Garneau	2013	N/A	USA	Uncontrolled longitudinal study comparing an adapted group-based mindfulness program for the prevention of stress in	A total of 58 young adult (mean age: 26.0 years; SD: not reported) male and	twice weekly sessions of 2.5 hours each of a group-based mindfulness program based on a manualised mindfulness-based program, consisting of:	No specific information	4 Weeks	Anxiety: not assessed. Burnout: Maslach Burnout Inventory, Human Services Survey (used Emotional Exhaustion subscale) Depression: BDI-II.

				medical students in their fourth year at one university	female (74.0% were female) medical students in their fourth year at one university.	mindful communication, body-scan techniques, yoga, sitting meditation, imagery meditation, and breathing exercises. Participants also attended a single day six hour long retreat day at the end of the course. Sessions were facilitated by two trained PhD-level psychologists and a palliative care physician. Participants also received a home practice manual and three CDs of materials to facilitate practice at home.			Stress: Perceived Stress Scale-10. Suicidality: not assessed. Other outcomes: self-compassion (Self-Compassion Scale), mindfulness skills (Mindful Attention Awareness Scale), and wellness (Scales of Psychological Well-Being).
Greenon	2015	N/A	USA	Uncontrolled, prospective, longitudinal study comparing four-sessions of a mind-body program for the prevention of stress in medical students in their first, second, third, or fourth years at one university. Two post-graduate students studying at the same university were also included.	A total of 44 young adult (mean age not reported) male and female (65.9% were female) medical students in their first, second, third, fourth, or studying a combined Master/Doctorate degree at one university. No specific exclusion criteria were reported.	Consisted of an adapted, four week, program based on a manualised mind-body skills program. Each session (1.5 hours) commenced with facilitator-led meditation, mindfulness, relaxation breathing, guided imagery, drawing, body awareness, progressive muscle relaxation, and loving-kindness. Each session concluded with a didactic discussion on the science of mind-body medicine, a period of reflection, and information on stress management. Between sessions, students were encouraged to engage in further mind-body skills training (for six days per week, of up to 30 minutes each session; mean duration: 12 minutes) facilitated by a recorded guided meditation program. Students were also asked to maintain a weekly diary.	No specific information	4 Weeks	Anxiety: not assessed. Burnout: not assessed. Depression: not assessed. Stress: PSS. Suicidality: not assessed. Other outcomes: mindfulness skills (Cognitive and Affective Mindfulness Scale-Revised).
Hassed	2009	N/A	Australia	Uncontrolled longitudinal study comparing an eight session mindfulness-based intervention for the prevention of stress in undergraduate medical students in their first year at one university.	A total of 148 young adult (mean age: 18.8 years; SD: 1.1 years) male and female (57.4% were female) undergraduate medical students in their first year at one university.	Eight, one hour sessions of psychoeducation on the links between mental and physical health, mind-body practice, behaviour change strategies, and mindfulness therapies. Students also received six two-hour sessions of a manualised Stress Release Program	No specific information	6 Weeks	Anxiety: subscale, SCL-90-R. Burnout: not assessed. Depression: subscale, SCL-90-R. Stress: not assessed. Suicidality: not assessed. Other outcomes: hostility (subscale, SCL-90-R), physical health (subscale, WHOQOL-BREF), psychological health (WHOQOL-BREF). Also measured overall Global Severity Index.

						<p>facilitated by trained tutors. Program components consisted of: mindfulness meditation, and mindfulness-based cognitive tasks. Students also received a single hour-long session of a mindfulness program (ESSENCE Lifestyle) with specific components on: reflection, mindfulness, spirituality, coping, physical activity, nutrition, and social support. Weekly mindfulness homework exercises were also provided, and students were encouraged to record progress in a personal journal.</p>			
Kötter	2016	N/A	Germany	Uncontrolled longitudinal study comparing a two-session progressive muscle relaxation training intervention for the prevention of stress in medical undergraduate students in their first and second years at one university.	A total of 122 young adult (mean age: 21.3 years; SD: 2.9 years) male and female (68.9% were female) undergraduate medical students in their first and second years at one university.	Two sessions (of 45 minutes duration each) of a progressive muscle relaxation intervention.	No specific information	Unclear "The first module...[was] followed by a refresher module several weeks later" (p. 3).	<p>Anxiety: State-Trait Anxiety Index. Burnout: not assessed. Depression: subscale, Brief Symptom Index. Stress: Perceived Medical School Stress, German language translation. Suicidality: not assessed. Other outcomes: self-rated general health (single item: How would you describe your health in general, rated on a five-point scale from very good to very poor), mental health (Hospital Anxiety and Depression Scale, German language translation), professional commitment (Arbeitsbezogene Verhaltens-und Erlebensmuster Scale), resistance to stress (Arbeitsbezogene Verhaltens-und Erlebensmuster Scale), and emotional well-being at work (Arbeitsbezogene Verhaltens-und Erlebensmuster Scale).</p>
Mercer	2010	N/A	USA	Uncontrolled longitudinal study comparing two sessions of a visual journaling intervention for the prevention of stress in medical students in their first year at one university.	A total of five young adult (mean age: not reported) medical students in their first year at one university and five (mean age: not reported) adult faculty members (proportion female not reported) at one university medical school.	Two sessions (duration not reported) of a visual journaling intervention. Sessions commenced with guided imagery visualisation focusing on breathing exercises and the identification of stress-producing emotions. In the first, participants drew images of their stressors and were provided with a series of exploration questions designed to help them understand the source(s) of their stress and what the imagery contained in their image may be conveying. In the second session,	No specific information	2 Weeks	<p>Anxiety: State-Trait Anxiety Index. Burnout: not assessed. Depression: not assessed. Stress: not assessed. Suicidality: not assessed. Other outcomes: negative affect (PANAS), positive affect (PANAS).</p>

						participants were guided to envision a less stressful image which was followed by another list of self-exploration questions.			
Simard	2009	N/A	Canada	Uncontrolled longitudinal study comparing a 16 week Hatha yoga program for the prevention of stress in medical students in their first year at one university.	A total of 16 young adult (mean age: 22.0 years; SD: 2.2 years) male and female (56.0% were female) medical students in their first year at one university.	16 weekly sessions (duration not reported) of a Hatha yoga program delivered by a certified Kripalu yoga teacher with over six years' experience.	No specific information	16 Weeks	Anxiety: not assessed. Burnout: not assessed. Depression: CES-D. Stress: PSS. Suicidality: not assessed. Other outcomes: general health functioning (General Health Questionnaire, 12 item).
Wild	2014	N/A	Germany	Uncontrolled longitudinal study comparing a semester long program (number of weeks unclear) for the prevention of burnout in medical undergraduate students in their third and fourth years at one university.	A total of 42 young adult (mean age: 24.9 years; SD: 4.4 years) male and female (88.1% were female) undergraduate medical students in their third and fourth years at one university.	Weekly sessions (of two hours' duration each) of a autogenic training and progressive muscle relaxation program. Students also were encouraged to participate in twice daily independent practice sessions to review course components and elaborate on the autogenic training and progressive relaxation techniques taught.	No specific information	Unclear	Anxiety: STAI, German language version (STAI-G). Burnout: Burnout Symptom Scale, version two (BOS-II) (cognitive subscale). Depression: BDI-II. Stress: not assessed. Suicidality: not assessed. Other outcomes: sense of coherence (Sense of Coherence Scale), and work related experiences (Arbetsbezogones Verhaltens und Erlebensmuster).
Curriculum-Based Interventions									
Al-Faris	2014	N/A	Saudi Arabia	Historically controlled, retrospective study comparing a redesigned curriculum focusing on systemically addressing sources of stress with a traditional curriculum on depression in undergraduate medical students in their first and second years at one university.	A total of 707 young adult (age range: 18-21 years) male and female (34.5% female) undergraduate medical students in their first and second years at one university.	Consisted of a number of changes to the curriculum to systemically address sources of stress, including: restructuring traditional subjects into new integrated subjects organised by bodily system and adopted a problem-based learning strategy consisting of interactive lectures and self-directed learning delivered in a small group format. New subjects designed to provide students with early, hands-on contact with the health care system (e.g., ambulatory care training), and increases to the amount of time students spent on internships were also instituted.	Consisted of a traditional curriculum which focused on didactic lectures as the main teaching format. Students were taught traditional subjects (e.g., anatomy, physiology) with little integration of the various bodily systems, and undertook few electives. In addition, grading was largely based on summative assessment (i.e., grades ranged from A+ to Fail)	Not clearly reported	Anxiety: not assessed. Burnout: not assessed. Depression: BDI-II. Stress: not assessed. Suicidality: not assessed. Other outcomes: perceived quality of the educational environment (Dundee Ready Educational Environment Measure; DREEM).
Camp	1994	N/A	USA	Non-randomised controlled trial comparing a problem-based learning curriculum with a traditional, lecture-based learning curriculum on	A total of 232 young adult (mean age: not reported) male and female (proportion female not reported) medical students in their first year at one university. No specific	consisted of a student-directed, problem-based learning curriculum which emphasises self-directed learning using problem-solving strategies in a small group	Consisted of a lecture-based learning curriculum which emphasises didactic teaching, typically in the format of a	1 Year	Anxiety: not assessed. Burnout: not assessed. Depression: Zung Self-Rating Depression Scale, using a cut off score of 60 or greater, indicating moderate to severe depression. Stress: not assessed.

				depression in medical students in their first year.	exclusion criteria were reported.	format facilitated by two faculty members. Students therefore have frequent one-on-one contact with faculty members throughout the year. Assessment also emphasizes understanding and took the format of an essay and/or performance-based examination every 10 weeks	discipline-specific lectures, delivered to a large group of students. There is therefore limited one-on-one contact with faculty members. Assessment emphasizes the use of infrequent, multiple-choice examinations.		Suicidality: not assessed. Other outcomes: self-actualisation (California Psychological Inventory; CPI).
Moffat	2004	N/A	UK	Uncontrolled longitudinal study comparing a redesigned curriculum focusing on systemically addressing sources of stress in first year medical undergraduate students at one university.	A total of 275 young adult (mean age: 18.7; age range: 17.2-29.0 years) male and female (54.9% were female) undergraduate medical students at one university in their first year.	introduction of a problem-based curriculum which consisted of a number of changes to the curriculum to systemically address sources of stress, including: a reduction in the number of lectures in favour of group-based problem-oriented tutorial sessions with around half of the timetable dedicated to self-directed personal study.	No specific information	1 Year	Anxiety: not assessed. Burnout: not assessed. Depression: not assessed. Stress: not assessed. Suicidality: not assessed. Other outcomes: coping style (Brief COPE), exposure to stressors (idiosyncratic list of 59 potential stressors), and psychological morbidity (GHQ-12).
Slavin	2014	N/A	USA	Historically controlled study comparing a redesigned curriculum focusing on systemically addressing sources of stress with a traditional curriculum on anxiety and depression in medical students in their first and second years at one university.	Young adult (mean age: not reported) male and female (proportion female not reported) medical students in their first and second years at one university. No specific exclusion criteria were reported.	Consisted of a number of changes to the curriculum to systemically address sources of stress, including: changing the grading system to pass/fail grading system, elimination of norm-referenced grading systems, a reduction in contact hours, the introduction of fewer, longer-term electives (of one half-day session every two weeks for a total of 12 days per academic year), the establishment of five learning communities (service and advocacy, research, global health, wellness, and medical education) composed of students and faculty members, the introduction of a compulsory resiliency and mindfulness program (of six hours over one semester) focusing on mindfulness cultivation, energy management, stress reduction, cognitive restructuring, adopting optimistic explanatory styles, and	Consisted of: an honours/near honours/pass/fail grading system, use of norm-reference grading systems for all subjects, a number of short-term electives (of one half-day session per week over a seven-week period) without any tie to any learning community, minimal student-faculty contact, and no resiliency training, mindfulness training, or formalised social events.	Not clearly reported	Anxiety: Spielberger State-Trait Anxiety Inventory. Burnout: not assessed. Depression: CES-D. Stress: PSS. Suicidality: not assessed. Other outcomes: cohesion (Perceived Cohesion Scale), satisfaction with the wellness program (Association of American Medical Colleges' Graduation Questionnaire).

						fostering character strengths, and the introduction of social events.			
Zuardi	2008	N/A	Brazil	Non-randomised controlled trial comparing a redesigned curriculum focusing on systemically addressing sources of anxiety with a traditional curriculum on anxiety in undergraduate medical students in their first, second, and third years at two campuses of one university.	A total of 637 young adult (mean age: not reported) male and female (proportion female not reported) undergraduate medical students in their first and second years at one university.	Consisted of a number of changes to the curriculum to systemically address sources of anxiety, including: restructuring traditional subjects into new integrated subjects organised by bodily system, the introduction of new subjects designed to provide students with early, hands-on contact with the health care system, and increases to the amount of time students spent on internships	Consisted of a traditional curriculum which focused on traditional subjects (e.g., anatomy, physiology), limited contact with the health care system outside of internships, and shorter internships.	Not clearly reported	Anxiety: Spielberger State-Trait Anxiety Inventory, Portuguese translation. Burnout: not assessed. Depression: not assessed. Stress: not assessed. Suicidality: not assessed. Other outcomes: not assessed.