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Christina Nielsen, BS, Sabrina Katz, BA, Meriah Parker, BS, Janelle Trefsgar, BS, Hend Bcharah, BS, Jacob Kalin, BS, Desiree Delavary, BA, Mark Brunk-Grady, MS and Breanne Jaqua*, DO, MPH

A student-driven mindfulness curriculum for first-year osteopathic medical students: a pilot study

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Abstract

Context: Medical education is stressful and can adversely affect the health and well-being of students. Although mindfulness-based interventions (MBIs) have been successfully utilized in other settings, little is known about the use of student-led interventions in undergraduate medical education.
Objectives: The objectives of this study are to assess student satisfaction with four student-selected and student-led mindfulness activities incorporated into mandatory small-group sessions, the immediate impact of these activities on student stress levels, and student use of these activities outside the mindfulness sessions.
Methods: First-year osteopathic medical students voluntarily participated in weekly student-selected and student-led mindfulness activities once a week for 8 consecutive weeks during regularly scheduled class time. Activities included yoga postures, the 4-7-8 breathing technique, progressive muscle relaxation (PMR), and values affirmation. Each activity was completed twice during the 8 weeks. After each session, students could anonymously complete an electronic survey assessing participation, change in stress level, satisfaction with the activity, and mindfulness activities practiced outside the session. Survey questions included dichotomous, Likert-like, and multiple-choice responses. A chi-square test was utilized to analyze student responses from each week about the decrease in stress level, and satisfaction with the mindfulness activity, and student use of the activities outside the classroom. Wilcoxon rank sum tests were utilized to determine associations between outcomes, and a logistic regression model was utilized to determine relationships between the change in stress levels and other outcomes.
Results: Of the 154 first-year medical students initially enrolled in the 2021–2022 academic year, 14 (9.1 %) to 94 (61.0 %) actively participated in the weekly mindfulness activities. Students indicated that the 4-7-8 breathing technique was the activity most practiced outside the mindfulness sessions (32.3 %, 43/133 total responses) across all weeks. The mindfulness activity with the highest percentage of reported decrease in stress level was the yoga postures in week 5 (94.8 %, 36/38), and both weeks of the yoga activities had the highest reported student satisfaction (95.7 %, 90/94 for week 1; 92.1 %, 35/38 for week 5). For students who answered the change in stress level question, the stress level decrease was related to participation in the weekly activity for weeks 1 through 7 (all $p<0.03$). For students who participated in mindfulness sessions, the odds of reporting a reduction in the stress level were 16.6 times (95 % CI, 6.8–47.2; $p<0.001$) that of students who did not participate. For those satisfied with the activities, the odds of reporting a reduction in stress level were 6.7 (95 % CI, 3.3–13.9; $p<0.001$).
Conclusions: Results suggested that the student-selected and student-led mindfulness activities may successfully reduce medical student stress in students who actively participate. However, additional research is needed to determine how to optimize mindfulness curricula implementation.

Keywords: medical student wellness; mindfulness-based interventions; osteopathic medical education; stress reduction; student driven

***Corresponding author: Breanne Jaqua**, DO, MPH, A.T. Still University, School of Osteopathic Medicine in Arizona, 5850 E Still Circle, Mesa, AZ 85206, USA; and Clinical Education Department, A.T. Still University School of Osteopathic Medicine in Arizona, Mesa, AZ, USA, E-mail: breannejaqua@atsu.edu. https://orcid.org/0000-0003-1189-2043
Christina Nielsen, BS, **Sabrina Katz**, BA, **Meriah Parker**, BS, **Janelle Trefsgar**, BS, **Hend Bcharah**, BS, **Jacob Kalin**, BS **and Desiree Delavary**, BA, A.T. Still University, School of Osteopathic Medicine in Arizona, Mesa, AZ, USA. https://orcid.org/0000-0003-1577-284X (C. Nielsen). https://orcid.org/0000-0002-3117-9563 (S. Katz). https://orcid.org/0000-0003-4451-4153 (M. Parker). https://orcid.org/0000-0001-9232-3779 (J. Trefsgar). https://orcid.org/0000-0001-7006-3435 (H. Bcharah). https://orcid.org/0000-0002-2022-8999 (J. Kalin)
Mark Brunk-Grady, MS, Department of Research Support, A.T. Still University, Kirksville, MO, USA. https://orcid.org/0000-0002-5571-9915

Medical education can be highly stressful and may place medical students' well-being and motivation at risk, contributing to burnout and depression [1–4]. A survey study conducted in 2014 of osteopathic medical schools in the United States found that

students who reported more stress were more likely to have burnout (39.9 %, n=1,294) and that 77 % met the criteria for depression [2]. Successful prevention of burnout requires medical students to cope with multiple stressors [4, 5]. Coping involves a conscious effort to regulate emotions, cognition, behavior, and the environment [4, 6]. Therefore, medical educators have investigated ways to reduce stress and promote student well-being, such as the use of mindfulness interventions [7].

Mindfulness can be defined as attending to the present moment [8, 9]. Specifically, it involves bringing nonjudgmental awareness to individual sensations and thoughts to promote an attitude of openness, patience, curiosity, and acceptance [9, 10]. Mindfulness-based interventions (MBIs) are techniques based on the practice of mindfulness [11]. Studies [10, 12–14] have shown that the integration of MBIs in schools and workplaces effectively reduces stress, anxiety, depression, and other biopsychosocial conditions. A systematic review of randomized controlled studies of MBIs in medical education concluded that MBIs are effective at reducing subjective stress in medical students [7]. The increased patience and acceptance that comes with mindfulness practice may also support the medical profession's goal of providing compassionate, patient-centered care [3].

At the institution of the current study, faculty-led mindfulness activities, such as body scan exercises, gratitude journaling, paced breathing exercises, and self-compassion activities, have been previously utilized to promote student well-being. Limited research suggests that student-led mindfulness activities in medical education can be feasible and effective for improving the mental well-being of medical students [15–17]. However, to our knowledge, no other studies have investigated the incorporation of student-selected and student-led MBIs directly into an osteopathic medical curriculum or mandatory small-group sessions. Therefore, the purpose of the current study was to assess student satisfaction with four student-selected and student-led mindfulness activities incorporated into mandatory small-group sessions, the immediate impact of these activities on student stress levels, and student use of these activities outside the mindfulness sessions. We hypothesized that active participation in student-selected and student-led mindfulness activities would decrease student stress levels, increase student satisfaction, and increase the use of MBIs outside of the small-group sessions.

Methods

The current study utilized a survey design to evaluate the effects of student-selected and student-led mindfulness activities on first-year osteopathic medical students. The A.T. Still University-Arizona Institutional Review Board granted the study exempt status (IRB no. 2022–064). Only first-year students from the 2021–2022 academic year were included in the study. Participants were recruited utilizing an electronic flier that described the study and participation requirements. The flier also clarified that participation was voluntary and that data would be collected anonymously. Although written informed consent was not required because of the exempt status of the study, a paragraph was provided at the beginning of each survey that outlined the intended use of collected data, the contact information of the study investigators, and available mental health resources. Students were invited to complete the survey after weekly mindfulness activities by scanning a QR code. Students could participate in the activities without completing the survey or complete the survey without participating in the activities. The mindfulness activities were not graded and were not a mandatory component of the curriculum; students were not compensated for their participation. The study was not funded. Safety of the participants was maintained throughout the study, and students could contact the study investigators at any time if they had questions or concerns or wanted to request additional information.

Mindfulness activities

Before this study, faculty-led mindfulness activities occurred weekly before mandatory, in-person, case-based small-group learning sessions. Therefore, the student-selected and student-led mindfulness activities were conducted once a week during regularly scheduled class time immediately before mandatory, in-person small-group learning sessions that were part of the renal/gastrointestinal block. One activity per week was introduced for 8 consecutive weeks from March to May 2022 and lasted approximately 5–10 min each week, depending on the activity. Four types of activities were included—yoga postures, the 4-7-8 breathing technique, progressive muscle relaxation (PMR), and values affirmation—and each activity was completed twice during the 8 weeks. Mindfulness activities started with a brief and informative PowerPoint presentation about that week's activity that was broadcast to the classroom of each small group. Next, depending on the activity, a live-stream video of the student guiding the activity or an existing video of the activity was broadcast to each classroom.

Yoga postures: This mindfulness activity was provided during weeks 1 and 5. Yoga postures were led by a student with 4 years of experience practicing yoga, experience teaching yoga to kindergarteners, and formal training in yogic principles and practices. The following postures were included: Mountain Pose (Tadasana), Standing Forward Fold, Seated Cat Cow, Seated Eagle Arms with Back Extension, Shoulder to Ear Pose, and Easy Pose (Sukhasana). In addition to the live-stream video, a PowerPoint slide of the yoga postures was provided in each classroom utilizing images from Tummee.com [18], a yoga sequencing platform for yoga teachers. Students were encouraged to modify postures to what felt good for their body, which also empowered them to be present in the moment.

The specific postures were chosen based on the limited space in the classrooms and recommendations from *Mindfulness and Yoga in Schools*: *A Guide for Teachers and Practitioners* [19]. Because medical students have a high prevalence of musculoskeletal pain in the neck, spine/back, and shoulder regions [20, 21], the postures focused on those regions. Despite a lack of research investigating yoga's ability to reduce stress and promote wellness in medical students, a review study [22] of yoga as stress management for healthcare workers found that consistent yoga practice managed stress and prevented burnout, which supported inclusion of yoga in the current study.

4-7-8 breathing technique: This mindfulness activity was provided during weeks 2 and 6. Students were guided through a breathing exercise called the 4-7-8 breathing technique [23] and were encouraged to work toward a maximum of eight breath cycles during the activity. During the live session, a YouTube video of Dr. Andrew Weil performing the 4-7-8 breathing technique [24] was provided in a PowerPoint slide

and broadcast to the classroom of each small group. After the video, a student led the technique utilizing live-stream video while a PowerPoint presentation was simultaneously broadcast to the classroom of each small group. The presentation outlined the technique steps as follows:

(1) Obtain heart rate before beginning (optional).
(2) Place the tip of the tongue on the ridge of tissue behind the front teeth.
(3) Breathe in through the nose for a count of 4 s.
(4) Hold the breath in the belly for a count of 7 s.
(5) Blow out through the lips (like blowing up a balloon) for a count of 8 s.
(6) Repeat three times for a total of four breath cycles.
(7) Recheck heart rate and compare with initial heart rate (optional).

This technique was included as a mindfulness activity because of a systematic review [25] that suggested that diaphragmatic breathing may decrease physiological and psychological stress.

Progressive muscle relaxation: This mindfulness activity was provided during weeks 3 and 7. The technique [26] requires active engagement of different muscle groups for a few seconds before relaxing them. This contraction and relaxation of different muscle groups generally starts at the feet and works up the body to the head [27]. During the live session, a YouTube video from Johns Hopkins Rheumatology [28] was provided in a PowerPoint slide and broadcast to the classroom of each small group. The video guided students through a 5-min PMR sequence. This technique was included as a mindfulness activity because it has been shown to reduce stress, positively influence depression and anxiety, and improve academic performance [26, 28].

Values affirmation: This mindfulness activity was provided during weeks 4 and 8. The exercise involved written reflection of the student's values. Based on the self-affirmation theory [29], it was intended to promote feelings of integrity or centeredness in difficult situations. The values affirmation included in this activity was derived from previous studies [29–31]. During the live session, a student volunteer guided the other students through the values affirmation utilizing live-stream video. The content was also outlined in a PowerPoint presentation and broadcast to the classroom of each small group. Instructions for the activity were as follows:

(1) Take 5 min to write a list of things that you consider personally valuable in your life (e.g., values, people, activities).
(2) Next, rank your values in order of personal importance.
(3) Write a few sentences explaining why that highest ranked value is important to you.

This technique was included as a mindfulness activity because self-affirmation and values affirmation practices significantly improve performance during chronic stress in student populations [26], reduce defensive avoidance in threat-prone individuals [31], and ameliorate examination achievement gaps for underrepresented minorities [32]. Studies [33–35] have also shown that self-affirmation leads to lower physiological responses to stress [33], enhances neural reward pathways [34], and facilitates health behavior change [35].

Electronic survey

After each weekly mindfulness activity, a PowerPoint slide displayed a QR code and URL link to the electronic survey. The survey was created specifically for the current study and took approximately 1 min to complete. It was designed to assess student participation, change in stress level, satisfaction with the activity, and mindfulness activities practiced outside the session in the past week (Table 1). The survey was built with Qualtrics and utilized the skip logic function. Questions included dichotomous, Likert-like, and multiple-choice responses. There were seven questions in the survey, but the total number of questions per student depended on their responses. For the week 1 survey, question 5 was omitted, and question 6 was modified as an open-ended response. Question 7 was included in the week 8 survey only, and students could select more than one response for this question. Because the survey was voluntary, students were not required to complete the survey or answer all survey questions. Participant identifiers were not utilized; therefore, the number of unique students participating in the study were not tracked.

Statistical analysis

Survey responses were summarized utilizing frequency and percentage, and the data were analyzed utilizing R statistical software version 4.1.2 [36] and RStudio Prairie Trillium [37]. Data cleaning was performed utilizing the reshape [38], xfactor [39], data. table [40], and tidyverse [41] packages. Survey questions about change in stress level and satisfaction with the activity utilized a 5-point Likert-like scale. For analysis, student responses to these questions were transformed to binary measures: significantly decreased or slightly decreased and very satisfied or satisfied responses were coded as "yes," and all other responses, except for decline to answer, were coded as "no." A chi-square test was utilized to analyze student responses from each week about decrease in stress level and satisfaction with the mindfulness activity. For these analyses, only responses from students who actively participated in the weekly mindfulness activities were included. A chi-square test was also utilized to analyze student responses about mindfulness activities practiced outside the session in the past week, the use of mindfulness activities learned during the 8 weeks and practiced outside the session in the past week, and mindfulness activities likely to be utilized in the future. For these analyses, responses from all students were included regardless of whether they actively participated in the weekly mindfulness activities because students did not need to actively participate to learn the techniques. Wilcoxon rank sum tests were utilized to evaluate associations between the change in stress level or satisfaction with the activity and student participation or mindfulness activities practiced outside the session in the past week. A logistic regression model was utilized to evaluate the relationship between the binary decrease in stress level and student participation, satisfaction with the activity, and mindfulness activities practiced outside the session in the past week. Responses from those who actively participated but declined to answer were excluded from all analyses. A $p<0.05$ was considered significant.

Results

Student participation

Of the 154 first-year medical students initially enrolled in the 2021–2022 academic year, 14 (9.1 %) to 94 (61.0 %) actively participated in the weekly mindfulness activities as reported in question 1 of the survey. The total survey responses ranged from 106 in week 1–23 in week 8. Because survey participation was not limited to students who actively participated, on the survey, 6 (3.9 %) to 16 (10.4 %) students indicated they did not actively participate, and 0 (0 %) to 4 (2.6 %) declined to answer.

Table 1: Electronic survey questions utilized in the current study.

No.	Question	Potential responses
1	Did you actively participate in today's mindfulness activity?	Yes No Decline to answer
2	Did your level of stress change as a result of this activity?	Significantly decreased Slightly decreased Neither increased nor decreased Slightly increased Significantly increased Decline to answer
3	Are you satisfied with today's activity?	Very satisfied Satisfied Neither satisfied nor dissatisfied Dissatisfied Very dissatisfied Decline to answer
4	Did you practice a mindfulness activity outside of small groups in the past week?	Yes No Decline to answer
5[a]	If you answered yes to the above question, did you incorporate any mindfulness activities you learned in renal/gastrointestinal small groups?	Yes No Decline to answer
6[a]	If you answered yes to the above question, which activity or activities did you utilize?	Yoga postures 4-7-8 Breathing technique Progressive muscle relaxation Values affirmation Other Decline to answer
7[b]	Which of the following mindfulness activities introduced in the renal/gastrointestinal block (if any) are you most likely to utilize in the future?	Yoga postures 4-7-8 Breathing technique Progressive muscle relaxation Values affirmation None Decline to answer

[a]Question 5 was not included in the week 1 survey, and question 6 was modified as an open-ended response. For weeks 2–8, the Qualtrics skip logic function was utilized, so questions 5 and 6 were only provided if the student responded yes to the previous question. For question 6, students could select multiple responses. [b]Question 7 was only included in the week 8 survey, and students could select multiple responses.

Change in stress level

The mindfulness activity associated with the highest percentage of reported decrease in stress level was the yoga postures in week 5 (94.8 %, 36/38) (Table 2). The activity with the lowest percentage of reported decrease in stress level was the values affirmation in week 4 (55.8 %, 24/43). When comparing responses, a difference in reported stress level was found for weeks 1, 2, 3, 5, and 7 (all $p<0.01$).

Table 2: Student responses about decrease in stress level during 8 weeks of student-selected and student-led mindfulness activities.

Session[a]	No. (%)[b]			p-Value
	Yes	No	Decline to answer	
Week 1 (n=94)	73 (77.7)	21 (22.3)	0 (0)	<0.001
Week 2 (n=35)	30 (85.7)	5 (14.3)	0 (0)	<0.001
Week 3 (n=48)	38 (79.2)	10 (20.8)	0 (0)	<0.001
Week 4 (n=43)	24 (55.8)	19 (44.2)	0 (0)	0.45
Week 5 (n=38)	36 (94.8)	2 (5.3)	0 (0)	<0.001
Week 6 (n=20)	14 (70.0)	6 (3.0)	0 (0)	0.07
Week 7 (n=22)	17 (77.3)	5 (22.7)	0 (0)	0.01
Week 8 (n=15)	9 (60.0)	5 (33.3)	1 (6.7)	0.29

Percentages may not add to 100 % because of rounding. [a]Yoga postures were provided in weeks 1 and 5, the 4-7-8 breathing technique in weeks 2 and 6, progressive muscle relaxation in weeks 3 and 7, and values affirmation in weeks 4 and 8. [b]Student responses to this 5-point Likert-like question were transformed to a binary measure, in which significantly decreased and slightly decreased responses were coded as "yes," and all other responses, except for "decline to answer," were coded as "no."

Satisfaction with the activity

The 2 weeks when the yoga postures mindfulness activity was taught had the highest percentage of student satisfaction (95.7 %, 90/94 for week 1; 92.1 %, 35/38 for week 5) (Table 3). The values affirmation activity in week 4 had the lowest percentage of student satisfaction (76.7 %, 33/43). When comparing responses, differences in reported satisfaction with the activities were found for all 8 weeks (all $p<0.008$).

Mindfulness activities practiced outside the session

The highest percentage of students reported practicing mindfulness activities outside the session in week 8 (52.2 %, 12/23) (Table 4). Week 2 had the lowest reported percentage of student use of these activities outside the session (34.8 %, 16/46). For the open-ended survey question in week 1, students indicated that they utilized yoga, meditation, journaling, prayer, or time outside as mindfulness activities. For students who reported utilizing a mindfulness activity in the past week that was learned during a previous session, the highest percentage was reported in week 6 (26.9 %, 7/26) (Supplementary Material). When comparing responses, no differences were found (all $p>0.53$). Students indicated that the 4-7-8 breathing technique was the activity most practiced

Table 3: Student responses about satisfaction with the mindfulness activity during 8 weeks of student-selected and student-led mindfulness activities.

Session[a]	No. (%)[b]			p-Value
	Yes	No	Decline to answer	
Week 1 (n=94)	90 (95.7)	4 (4.3)	0 (0)	<0.001
Week 2 (n=36)	32 (88.9)	3 (8.3)	1 (2.8)	<0.001
Week 3 (n=47)	40 (83.3)	7 (16.7)	0 (0)	<0.001
Week 4 (n=43)	33 (76.7)	10 (23.3)	0 (0)	<0.001
Week 5 (n=38)	35 (92.1)	3 (7.9)	0 (0)	<0.001
Week 6 (n=20)	18 (90.0)	2 (10.0)	0 (0)	<0.001
Week 7 (n=22)	18 (81.8)	4 (18.2)	0 (0)	0.003
Week 8 (n=15)	12 (80.0)	2 (13.3)	1 (6.7)	0.008

Percentages may not add to 100 % because of rounding. [a]Yoga postures were provided in weeks 1 and 5, the 4-7-8 breathing technique in weeks 2 and 6, progressive muscle relaxation in weeks 3 and 7, and values affirmation in weeks 4 and 8. [b]Student responses to this 5-point Likert-like question were transformed to a binary measure, in which very satisfied and satisfied responses were coded as "yes," and all other responses, except for "decline to answer," were coded as "no."

Table 4: Student responses about mindfulness activities practiced outside the session in the past week during 8 weeks of student-selected and student-led mindfulness activities.

Session[a]	No. (%)			p-Value
	Yes	No	Decline to answer	
Week 1 (n=106)	37 (34.9)	67 (63.2)	2 (1.9)	0.004
Week 2 (n=46)	16 (34.8)	28 (60.9)	2 (4.3)	0.06
Week 3 (n=63)	30 (47.6)	32 (50.8)	1 (1.6)	0.77
Week 4 (n=59)	24 (40.7)	31 (52.5)	4 (6.8)	0.21
Week 5 (n=46)	21 (45.7)	24 (52.2)	1 (2.2)	0.10
Week 6 (n=26)	12 (46.2)	13 (50.0)	1 (3.8)	0.65
Week 7 (n=38)	18 (47.4)	20 (52.6)	0 (0)	0.67
Week 8 (n=23)	12 (52.2)	9 (39.1)	2 (8.7)	0.80

Percentages may not add to 100 % because of rounding. [a]Yoga postures were provided in weeks 1 and 5, the 4-7-8 breathing technique in weeks 2 and 6, progressive muscle relaxation in weeks 3 and 7, and values affirmation in weeks 4 and 8.

outside the mindfulness sessions (32.3 %, 43/133 total responses) across all weeks, and it was the activity most likely to be utilized in the future (41.9 %, 13/31) (Table 5).

Comparisons between student responses

For students who answered the change in stress level question, a decrease in stress was related to participation in the weekly activity for weeks 1 through 7 (all $p<0.03$). There was a borderline association in week 8 ($p=0.06$). For the students who participated, they reported having increased satisfaction in the weekly activity for each week (all $p<0.02$). For those students who participated in the mindfulness activities, the odds of having decreased stress were 16.6 times (95 % CI, 6.8–47.2; $p<0.001$) that of students who did not participate, after controlling for satisfaction with the activity and activities practiced outside the session. For those students who reported that they were satisfied with the activities, the odds of reporting a reduction in stress level were 6.7 (95 % CI, 3.3–13.9; $p<0.001$), after controlling for student participation and activities practiced outside the session. When comparing the reported decrease in stress level with activities practiced outside the sessions, there was no relationship overall ($p=0.61$) or by weekly session (all $p>0.14$).

Discussion

The current study assessed student satisfaction with four student-selected and student-led mindfulness activities incorporated into mandatory small-group sessions, the immediate impact of these mindfulness activities on student stress levels, and student use of these mindfulness activities outside the mindfulness sessions. Survey results indicated that first-year osteopathic medical students who actively participated in the weekly mindfulness activities experienced a reduction in stress in 5 of the 8 weeks and were satisfied with the activities for all 8 weeks. These results support the existing evidence that suggests that mindfulness curricula in medical education may decrease stress [7, 14]. Because MBIs like those utilized in the current study are quick, inexpensive, and accessible online, they are easy to incorporate into existing curriculum models and address the challenges of feasibility and time limitations [12].

Concurrent curriculum

The student-selected and student-led mindfulness activities of the current study were conducted during the 8-week renal/gastrointestinal block. Including osteopathic principles and practices and medical skills curriculum, students had written examinations on Mondays of weeks 3, 7, and 8 and on Tuesday of week 5. Practical examinations were held on Thursdays of weeks 2 and 7. Despite comparable amounts of coursework (22.75 h including examinations), week 5 was condensed into 4 days for the Easter holiday. Scheduled coursework ranged from 20.5 h during week 7 (examinations included) to 23.75 h during weeks 3 and 8 (examinations included). In addition to the scheduled coursework, students prepared anatomy laboratory presentations to teach to other students during weeks 2, 4, 5, 7, and 8. Because the average coursework and number of examinations remained

Table 5: Student responses about which mindfulness activities were utilized in the past week and likely to be utilized in the future during 8 weeks of student-selected and student-led mindfulness activities.

Session[a]	No. (%)						p-Value
	Yoga postures	4-7-8 breathing technique	Progressive muscle relaxation	Values affirmation	Other/none[b]	Decline to answer	
Which activity or activities did you utilize?							
Week 1 (n=108)	9 (8.3)	1 (0.9)	0 (0)	0 (0)	24 (22.2)	74 (68.5)	< 0.001
Week 2 (n=50)	4 (8.0)	4 (8.0)	0 (0)	2 (4.0)	0 (0)	40 (80.0)	0.09
Week 3 (n=68)	4 (5.9)	9 (13.2)	1 (1.5)	1 (1.5)	0 (0)	53 (77.9)	0.001
Week 4 (n=65)	4 (6.2)	8 (12.3)	0 (0)	4 (6.2)	0 (0)	49 (75.4)	0.007
Week 5 (n=52)	7 (13.5)	5 (9.6)	3 (5.8)	1 (1.9)	0 (0)	36 (69.2)	0.04
Week 6 (n=34)	3 (8.8)	6 (17.6)	2 (5.9)	3 (8.8)	1 (2.9)	19 (55.9)	0.32
Week 7 (n=47)	4 (8.5)	6 (12.8)	5 (10.6)	3 (6.4)	0 (0)	29 (61.7)	0.21
Week 8 (n=27)	1 (3.7)	4 (14.8)	2 (7.4)	3 (11.1)	0 (0)	17 (63.0)	0.29
Which mindfulness activities most likely to be utilized in the future[c]							
Week 8 (n=33)	4 (12.1)	13 (39.4)	3 (9.1)	8 (24.2)	3 (9.1)	2 (6.1)	0.006

Students could choose more than one response. Percentages may not add to 100 % because of rounding. [a]Yoga postures were provided in weeks 1 and 5, the 4-7-8 breathing technique in weeks 2 and 6, progressive muscle relaxation in weeks 3 and 7, and values affirmation in weeks 4 and 8. [b]Survey question 6 had "other" as a response option; question 7 had "none" as a response option. [c]Survey question 7 was only included in the week 8 survey.

steady throughout the block, it is unlikely that the concurrent curriculum had an effect on study results.

Student participation

The periodic practical and written examinations during the 8-week study did not appear to affect student participation. Despite the relative consistency of the curricular workload (20.5–23.75 h per week), survey participation declined during the 8-week study. Week 1 had the most survey respondents, possibly because it took place just after spring break when students may have had lower stress levels, leading to increased participation and satisfaction. The progressive decline in survey responses throughout the 8-week study may be due to several factors, such as competing demands on students' time, lack of interest, lack of perceived benefit, and/or survey fatigue [42]. It is also possible that some students may have decided to not complete the survey for personal reasons or because of the redundancy of the interventions and survey questions.

Change in stress level and satisfaction with the activity

In most weeks, students reported a significant reduction in stress; however, the weeks with the values affirmation were consistent outliers for this result. Therefore, we recommend utilizing a different MBI in place of values affirmations in the future because fewer students reported immediate decreases in stress after this activity. Compared with the other activities, the lack of physical movement for values affirmation may explain this result. Despite having 22.75 h of coursework condensed into a 4-day week, the yoga postures activity during week 5 had the highest reported decrease in stress level and the highest reported student satisfaction. This result supported the psychological benefits of yoga practice found in a review study [19].

Use of mindfulness activities practiced outside the session

The use of mindfulness activities outside the sessions was inconsistent, and there was no clear relationship between in-class sessions and the use of mindfulness at home. However, the 4-7-8 breathing technique was the activity most practiced outside the sessions, and it was the most likely to be utilized in the future, possibly because of its minimal implementation barriers. Yoga was reported to be the second most commonly utilized mindfulness activity outside the sessions. The majority of students who completed the survey did not practice mindfulness outside the session. These results are consistent with a similar study that reported that students found it challenging to engage in daily mindfulness practices at home and were more likely to practice yoga or mindfulness during daily activities [16].

Limitations

The current study has several limitations. Because students self-selected to participate in mindfulness activities and complete the study surveys, selection bias is an inherent limitation of our study. Further, the observed decline in participation throughout the study may have affected the results and our subsequent conclusions. For example, the students who did not respond to the survey may have experienced no benefit from the mindfulness activities, which may have skewed the results in favor of mindfulness. However, if the students who did not respond to the survey were the ones who benefited the most from the activities, then the results would likely underestimate the benefits of mindfulness. Surveys were completed anonymously, so individual student progress and changes over time could not be tracked. In addition, the study was performed at a single osteopathic medical school and only first-year students participated, which limited the generalizability of our results.

Future opportunities for student-led mindfulness activities

Overall, the results of the current study suggested that future investigation of student-selected and student-led mindfulness activities in medical education is warranted. Future research could also investigate optimization of scheduling to maximize student engagement or explore alternative mindfulness activities. Similar pilot studies involving student-led mindfulness curricula could be conducted at multiple osteopathic and allopathic institutions at all levels of medical education. In addition, future studies could assess the long-term stress reduction of mindfulness activities by utilizing validated tools, such as the Perceived Stress Scale, and tracking individual students throughout the study and after the 8-week intervention period.

Conclusions

Results of the current study indicated that incorporating student-selected and student-led mindfulness activities in the osteopathic medical education curriculum may successfully reduce stress levels in first-year osteopathic medical students who actively participate. During the 8-week study, student responses to our survey indicated significant reductions in stress for 5 of the 8 weeks and satisfaction with the activities for all 8 weeks. Given these results, medical educators should consider incorporating mindfulness activities to reduce stress and improve the well-being of medical students. However, additional research is needed to determine how to optimize the implementation of mindfulness curricula.

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