



AOA Critical Issues in Education

Mindfulness Applications

Can They Serve as a Stress, Anxiety, and Burnout Reduction Tool in Orthopaedic Surgery Training? A Randomized Control Trial

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Background: Stress and burnout are prevalent within the orthopaedic surgery community. Mindfulness techniques have been shown to improve wellness, yet traditional courses are generally time-intensive with low surgeon utilization. We sought to determine whether the introduction of a simple mindfulness-based phone application would help decrease stress, anxiety, and burnout in orthopaedic surgery residents.

Methods: Twenty-four residents participated in this prospective, randomized controlled trial. After simple 1:1 randomization, the treatment group received access to a mindfulness-based phone application for 2 months while the control group did not receive access. All participants completed the Perceived Stress Scale, Generalized Anxiety Disorder-7, and Maslach Burnout Inventory with emotional exhaustion (EE), depersonalization (DP), and personal accomplishment subscores to measure stress, anxiety, and burnout at baseline and after 2 months. Paired *t* tests were used to compare baseline scores and conclusion scores for both groups.

Results: There was no difference in baseline burnout scores between groups, but the treatment group had higher stress and anxiety scores at baseline. On average, the treatment group spent approximately 8 minutes per day, 2 days per week using the mindfulness application. After 2 months, the treatment group had significantly decreased stress (mean = -7.42 , $p = 0.002$), anxiety (mean = -6.16 , $p = 0.01$), EE (mean = -10.83 ± 10.72 , $p = 0.005$), and DP (mean = -5.17 ± 5.51 , $p = 0.01$). The control group did not have any significant differences in stress, anxiety, or burnout subscores.

Conclusions: Use of a mindfulness-based phone app for 2 months led to significant reductions in stress, anxiety, and burnout scores in orthopaedic surgery residents. Our results support the use of a mindfulness-based app to help decrease orthopaedic resident stress, anxiety, and burnout. Benefits were seen with only modest use, suggesting that intensive mindfulness training programs may not be necessary to effect a change in well-being. The higher baseline stress and anxiety in the treatment group may suggest that mindfulness techniques are particularly effective in those who perceive residency to be more stressful.

Level of Evidence: I

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Introduction

Physician burnout has plagued the medical community for decades. Studies show that rates of burnout are higher in physicians than the general population and have remained high, despite attention to this issue¹. Surgical subspecialties in particular are at an increased risk of experiencing physician burnout, given the demanding schedules, long work weeks, and poor work-life integration. Surgeons may also be at an increased risk of burnout due to maladaptive personality traits and mindsets that are reinforced in surgical training. Physician burnout is prevalent throughout all age groups, but it is experienced even at the earliest levels of training, with almost 50% of medical students experiencing burnout before their careers have even commenced². Evidence shows that burnout and physician stress can lead to depression, risk of suicide, poor patient outcomes, and medical errors²⁻⁵. One study found that nearly one third of orthopaedic surgeons have had suicidal ideation⁶.

Mindfulness is a type of meditation practice with a focus on nonjudgmental, present-centered awareness. It is based on meditative techniques but was designed as an intervention to assist with pain control 40 years ago⁷. Traditionally, Mindfulness-Based Stress Reduction (MSBR) consists of an 8-week course with weekly sessions led by a clinically trained instructor, concluding with a full day mindfulness retreat⁷. Since its inception, it has been adapted to many clinical settings to help improve pain, anxiety, depression, and substance abuse⁷.

There has been a recent push toward adapting mindfulness techniques as an intervention for reducing physician burnout and stress. Some studies have implemented MSBR curricula into residency programs or departments, whereas others have used mindfulness exercises in concert with group discussion⁸⁻¹². Systematic reviews have acknowledged that these interventions are beneficial, but there is no consensus on the best method of intervention¹³. Furthermore, many of these studies involve time-intensive curricula or programs. Orthopaedic surgeons already have long workdays, so implementing numerous hours a week into an intervention may exclude participants who need it most.

When mindfulness hit mainstream media attention, the techniques became available to the general public in the form of online videos, podcasts, and applications with guided meditation. Although the initial MSBR required in-person meetings for 1.5 to 3 hours per week plus 45-minute nightly homework assignments, recent programs have shortened the amount of interface time and allow for a more individualized experience. Studies have shown that shorter periods of daily meditation also reduce stress, anxiety, and physician burnout¹⁴⁻¹⁶, but there are limited quality studies within the surgical community. Many studies, both with mindfulness-based applications and more formal curricula, are weakened by small sample size, lack of a control group, or other biases¹⁶⁻¹⁸. None to date have examined the role of a mindfulness intervention within an orthopaedic surgery department. The primary objective of this study was to determine whether a mindfulness-based application could help decrease stress, anxiety, and burnout in orthopaedic surgery residents.

Materials and Methods

Trial Design

This was a prospective, single center, parallel-group study with simple 1:1 randomization.

Participants

Eligible participants were orthopaedic surgery residents from a single institution. After institutional review board approval, residents were recruited through word of mouth and a formal presentation at grand rounds after a wellness lecture. Prospective residents were informed that participation was entirely voluntary, responses would be coded, and results would not affect standing within the department. Simple randomization was used to separate participants into treatment and control groups.

Interventions

The treatment group received access to the popular mindfulness-based application “Headspace” for 2 months, whereas the control group did not receive access. The Headspace application offers guided meditations of varying lengths to promote mindfulness, improve sleep, increase focus, and relieve stress¹⁹. Residents were encouraged to use the application daily. The control group did not receive access to the application during the study period but were given the opportunity to use the application after the completion of the study.

Outcomes

The primary outcomes were stress, anxiety, and burnout. Stress was measured using the Perceived Stress Scale (PSS), with a score greater than 26 indicating high stress²⁰. Anxiety was measured using the Generalized Anxiety Disorder-7 (GAD-7), with a score greater than 14 indicating severe anxiety²¹. Burnout was measured using the Maslach Burnout Inventory-Medical Personnel (MBI), which measures burnout using emotional exhaustion (EE), depersonalization (DP), and personal accomplishment (PA) subscores²². The score cutoffs that indicated burnout were EE greater than 26, DP greater than 13, and PA less than 31²². Surveys were administered at baseline and at the conclusion of the 2-month study. At the end of the study, participants also completed a survey measuring satisfaction with the application and frequency of application use. All surveys were administered through emailed REDCap links²³.

Statistics

Paired *t* tests were used to compare mean changes in stress, anxiety, and burnout between baseline and posttreatment for both groups after confirming normality with a Shapiro-Wilk test. A Student *t* test was used to compare the treatment and control group for each outcome at both time points. The Chi-square test was used to compare prevalence rates between groups. A $p < 0.05$ was considered significant. Continuous variables are reported as mean \pm standard deviation. Statistical analysis was conducted using a publicly available online calculator.

Results

Participant Characteristics

A total of 24 residents participated in the study and were randomized into 2 groups of 12 (Fig. 1). All 24 residents completed all surveys and had their data included in analysis. The mean age of the treatment group was 31.0 ± 2.8 years, and the mean age of the control group was 30.6 ± 2.8 years (Table I). The control group had 4 women and 8 men, whereas the treatment group had 5 women and 7 men. There was a range of junior and senior residents in the control and treatment groups. On average, the treatment group spent 7.9 ± 6.6 minutes per day, 2 days per week using the mindfulness application. Eight of 12 residents in the treatment group were either satisfied or very satisfied with their mindfulness education, whereas the remaining 4 were neither satisfied nor dissatisfied.

Perceived Stress

Overall prevalence of high stress (PSS > 26) was 12.5%, with 3 of 12 of the treatment group and 0 of 12 of the control group meeting criteria at baseline. Posttreatment, 1 of 12 in the treatment group met criteria for high stress. At baseline, the treatment group had higher stress than the control group ($p = 0.008$), with scores of 23.1 ± 6.5 and 15.9 ± 5.6 , respectively. After 2 months, the treatment group had significantly decreased stress (mean = -7.42 ± 6.04 , $p = 0.002$), whereas the control group did not have a significant change in stress (mean = -0.64 ± 4.15 , $p = 0.62$) (Table II).

Anxiety

Overall prevalence of severe anxiety (GAD-7 > 15) was 16.7%, with 4 of 12 of the treatment group and 0 of 12 of the control group meeting criteria at baseline. Posttreatment, 0 of 12 in the treatment group met criteria for severe anxiety. At baseline, the treatment group had higher anxiety than the control group ($p = 0.001$), with scores of 11.6 ± 5.7 and 4.3 ± 2.9 , respectively. After 2 months, the treatment group had significantly decreased anxiety (mean = -6.16 ± 6.83 , $p = 0.01$), whereas the control group did not have a significant change in anxiety (mean = -0.45 ± 3.09 , $p = 0.65$) (Table II).

Burnout

Overall prevalence of burnout was 95.8%, with 11 of 12 of the treatment group and 12 of 12 of the control group meeting criteria at baseline in at least 1 burnout subscale (Fig. 2). Although not statistically significant, burnout prevalence in the treatment group decreased from 91.7% (11/12 residents) to 58.3% (7/12 residents) ($p = 0.059$). Burnout prevalence in the control group decreased from 100% (12/12 residents) to 91.7% (11/12 residents). There was no difference in baseline burnout subscale scores between groups (Table II). After 2 months, the treatment group had significantly decreased burnout from EE (mean = -10.83 ± 10.72 , $p = 0.005$) and burnout from DP (mean = -5.17 ± 5.51 , $p = 0.01$) but did not have a significant change in burnout from PA (mean = 1.0 ± 5.94 , $p = 0.17$) (Fig. 3). The control group did not have any significant

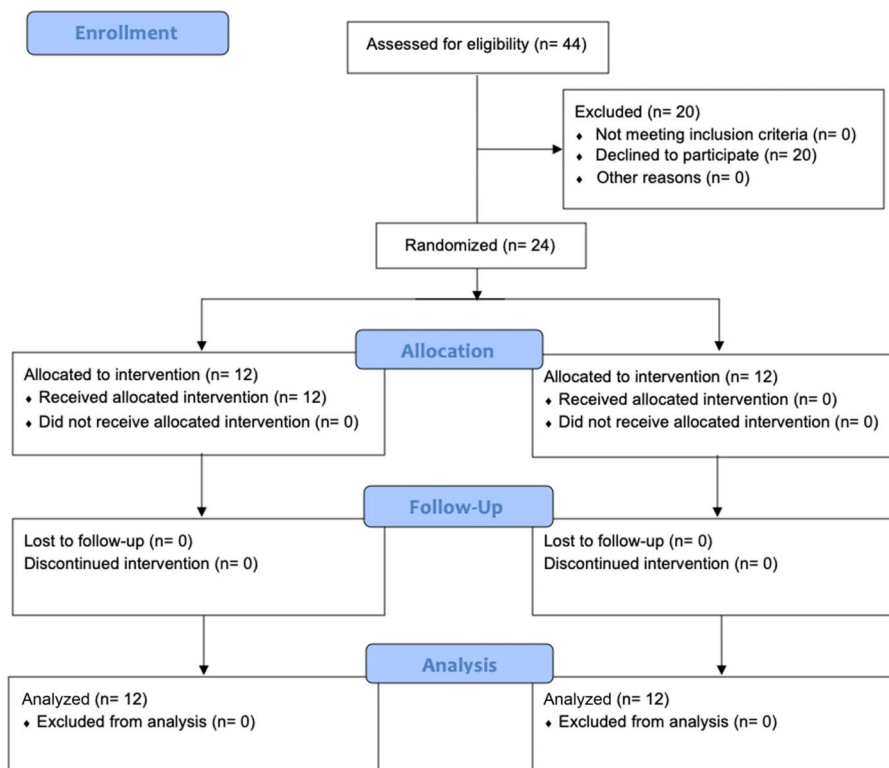


Fig. 1
CONSORT flow diagram of enrollment.

TABLE I Resident Characteristics*

| | Control (n = 12) | Treatment (n = 12) |
|------------------|---------------------|-----------------------|
| Male/female | 8/4 | 7/5 |
| Age ± SD (years) | 30.6 ± 2.8 | 31.0 ± 2.8 |
| PGY-1 | 4 | 2 |
| PGY-2 | 2 | 4 |
| PGY-3 | 3 | 0 |
| PGY-4 | 3 | 4 |
| PGY-5 | 0 | 2 |

*PGY = postgraduate year and SD = standard deviation.

differences in burnout from EE (mean = -2.91 ± 4.79 , $p = 0.08$), burnout from DP (mean = -0.92 ± 4.66 , $p = 0.17$), or burnout from PA (mean = 0.92 ± 4.66 , $p = 0.47$) (Fig. 4).

Discussion

In this randomized control study, we assessed perceived stress, anxiety, and burnout in orthopaedic surgery residents after utilization of a mindfulness-based application. The results confirmed that after a 2-month period of application use, treatment group members had greater decreases in PSS, GAD-7, and MBI subscores for EE and DP relative to controls. Unlike mandatory in-person interventions that have shown poor feasibility or no change in burnout^{11,12,17}, this was a voluntary phone app-based intervention. Residents were generally satisfied with the application, and 100% of participants completed the final survey.

Similar to previous studies on mindfulness interventions, stress and anxiety were decreased in the intervention group relative to controls^{8,17}. Most residents had perceived stress and anxiety scores within the normal range; however, changes in the mean score for PSS and GAD-7 were observed in the intervention group. The decrease in the PSS score of 7.2 is higher than the minimal clinically important difference (MCID) reported of 2.66 points²⁴. The decrease in GAD-7 of 6 seen in the

intervention group is greater than the MCID of 4 points²⁵. This suggests that the improved perceived stress and anxiety likely have clinical benefits even in residents who may have fallen within the normal range on baseline testing.

The burnout prevalence in our study population was extremely high at 98.5%. Past studies have estimated physician and surgeon burnout rates to be approximately 40% to 60%^{3,13,26,27}. This difference in prevalence may be a result of selection bias, with residents experiencing burnout being more likely to participate in the study. Alternatively, this may more accurately represent the prevalence of burnout in orthopaedic surgery residents because participants may have answered more honestly knowing the residency would not have access to any of the results.

Although mindfulness-based interventions have been shown to decrease some aspects of burnout in resident populations in the past^{8,13,16}, this is the first within the field of orthopaedic surgery to show a benefit. There was no change in PA subscore in the treatment group, which could indicate that mindfulness techniques covered in the application are not as effective in that aspect or burnout or that it takes more time to see a change. Although MCID data are not available for burnout subscores, a decrease in 10 points for EE from 37.6 to 26.8 represents a large change based on an item response theory analysis of the MBI²². In that analysis, 95% of physicians with a score of 37 endorsed feeling emotionally drained from work at least once a week, whereas only 56% of those with a score of 26 reported similar feelings. Similarly, a decrease in DP from 16 to 11 corresponded to a decrease of 60% to 15% of physicians reporting feeling more callous toward other people at least once a week.

Previous studies have found that even small changes in EE of 1 to 2 points can lead to noticeable improvement in the number of medical errors committed and a decrease in suicidal ideation^{3,4,28-30}. In light of a recent study showing that just over 30% of practicing orthopaedic surgeons report a history of suicidal ideation and the fact that many of the risks associated with suicidal ideation are not modifiable⁵, introducing mindfulness-based interventions may have profound effects on the orthopaedic surgery community at large.

TABLE II Perceived Stress, Anxiety, and Burnout in Orthopaedic Surgery Residents Before and After Mindfulness-Based Application*

| | Baseline, mean ± SD | | Posttreatment, mean ± SD | | Posttreatment change, mean ± SD | | p | |
|-------------------|---------------------|------------------|--------------------------|------------------|---------------------------------|------------|-----------|---------|
| | Treatment (n = 12) | Control (n = 12) | Treatment (n = 12) | Control (n = 12) | Treatment | Control | Treatment | Control |
| Burnout EE (0-48) | 37.6 ± 10.5 | 30.8 ± 8.7 | 26.8 ± 12.7 | 28.1 ± 8.2 | -10.8 ± 10.7 | -2.7 ± 4.8 | 0.005 | 0.07 |
| Burnout DP (0-30) | 16.3 ± 7.0 | 17.8 ± 5.7 | 11.2 ± 7.6 | 16.8 ± 6.6 | -5.2 ± 5.5 | -0.9 ± 4.7 | 0.008 | 0.17 |
| Burnout PA (0-42) | 30.4 ± 4.6 | 33.3 ± 6.3 | 32.8 ± 4.8 | 34.3 ± 4.9 | 1 ± 5.9 | 0.9 ± 4.7 | 0.17 | 0.47 |
| Stress (0-40) | 23.1 ± 6.5 | 15.9 ± 5.6 | 15.5 ± 5.3 | 14.8 ± 4.6 | -7.4 ± 6.0 | -1.0 ± 4.2 | 0.002 | 0.40 |
| Anxiety (0-21) | 11.6 ± 5.7 | 4.3 ± 2.9 | 5.4 ± 3.9 | 3.8 ± 2.6 | -6.2 ± 6.8 | -0.6 ± 3.1 | 0.01 | 0.53 |

*DP = depersonalization subscore, EE = emotional exhaustion subscore, PA = personal accomplishment subscore, and SD = standard deviation.

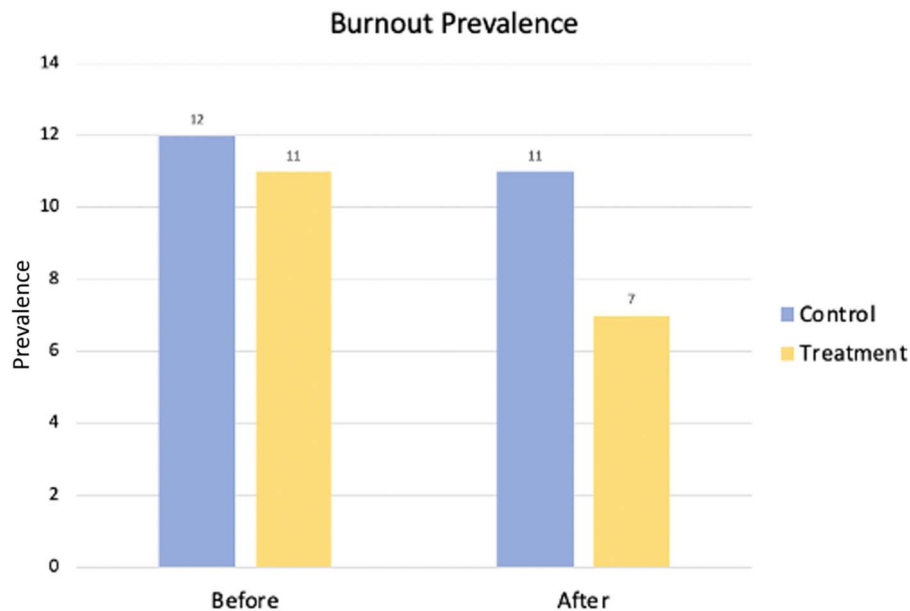


Fig. 2

Burnout prevalence in orthopaedic surgery residents before and after the use of a mindfulness-based application

Strengths of this study include its prospective, randomized, and controlled design. With 1:1 randomization in a large, diverse academic training center, the results are generalizable to orthopaedic surgery residents. The sample size was large for an orthopaedic surgery training program. The measurement tools used for perceived stress, anxiety, and burnout have been validated and consistently studied within the healthcare population. The presence of a control group improved on previous

studies within medical and surgical residency groups in that it allows for direct comparison and helps eliminate any potential outside sources of bias related to progression through an academic year, changes in rotation, or seasonal differences that may have otherwise influenced scoring for the outcomes measured over the study period.

This study is not without weaknesses. There was no way to blind participants, and thus it is impossible to eliminate the

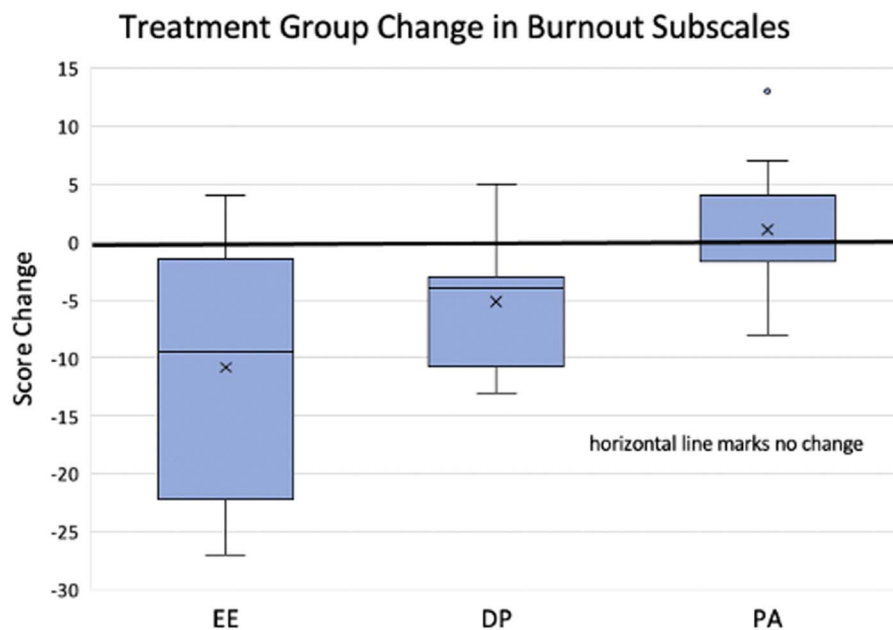


Fig. 3

Change in burnout subscores after use of mindfulness-based application. DP = depersonalization, EE = emotional exhaustion, and PA = personal accomplishment.

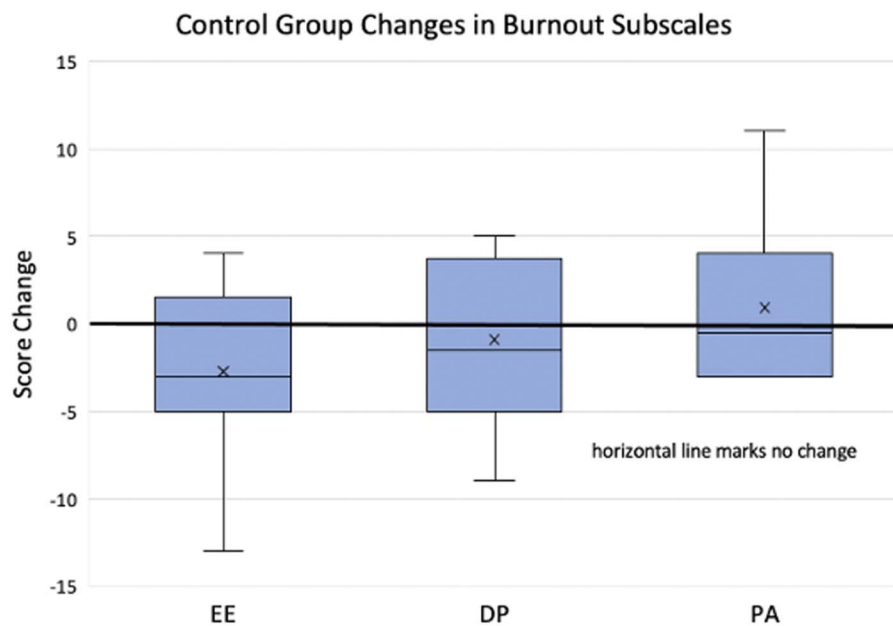


Fig. 4

Change in burnout subscores in the control group. DP = depersonalization, EE = emotional exhaustion, and PA = personal accomplishment.

Hawthorne effect. Sample size was limited and prevented subgroup analysis. Although a trend toward a reduction in overall burnout prevalence was noted from 91.7% to 58.3% of residents in the treatment group, this study was underpowered to detect overall changes in prevalence because of the limited sample size. In addition, there was no way to monitor use of the application, although participants reported their estimated interaction time with the application.

In conclusion, use of a mindfulness-based phone app improved perceived stress, anxiety, and burnout within orthopaedic surgery residents over a 2-month period. The flexibility of a phone app rather than more structured courses may increase its utilization within the orthopaedic surgery community. Reductions in stress, anxiety, and burnout were seen with only modest use of the mindfulness application, suggesting that intensive mindfulness training programs may not be necessary to effect a change in well-being. The higher baseline stress and anxiety in the treatment group may suggest that mindfulness techniques are particularly effective in those who perceive residency to be

more stressful. This was the first study of its kind in orthopaedic surgery residents and has implications for expansion into other training departments and to attending physicians. ■

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