

A Non -Randomized Study to Observe the Effect of Yoga on Anxiety, Stress and Depression Levels among Medical Students

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ABSTRACT

Background: Medical students commonly experience psychological stress, anxiety, and depressive symptoms. Yoga may offer a simple supportive strategy for improving mental well-being. **Materials and Methods:** A single-group pre-post intervention study was conducted among 96 medical students aged 18–23 years at M. S. Ramaiah Medical College, Bengaluru. Participants followed a structured yoga program for 1 year. Perceived stress was assessed using the Perceived Stress Scale-10 (PSS-10), while depression, anxiety, and stress were assessed using the Depression Anxiety Stress Scales-21. Pre- and post-intervention scores were compared using paired analyses. **Results:** Significant reductions were observed in PSS-10 scores (20.89 ± 6.54 – 17.89 ± 6.45), depression (12.83 ± 9.64 – 9.40 ± 8.45), anxiety (13.08 ± 8.12 – 5.58 ± 5.48), and stress (15.01 ± 8.68 – 9.31 ± 7.60), all $P < 0.001$. Anxiety showed the largest effect size (Cohen's $d_z = 1.02$). The proportion classified as normal for anxiety increased from 22.9% to 70.8%. **Conclusion:** One year of regular yoga practice was associated with significant improvement in perceived stress, depression, anxiety, and stress symptoms among medical students. Controlled studies are needed to confirm these findings.

Keywords: Anxiety, Depression, Medical students, Perceived stress, Yoga

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INTRODUCTION

Students are academically and emotionally challenged during medical education. Medical training is a rigorous process with multiple exams, competitive settings, and growing levels of responsibility. These pressures can impact mental health at a critical time in early adulthood. A large systematic review of medical students from multiple countries found the prevalence of depression or depressive symptoms to be 27.2%.^[1] There is also a high prevalence of anxiety. A meta-analysis of 69 studies showed an overall prevalence of anxiety of 33.8% among medical students.^[2]

This burden is also high among medical students in India. Sarkar *et al.* conducted a review of the Indian studies and reported a pooled prevalence of 39.2% depression, 34.5% anxiety and 51.3% stress.^[3] The results suggest that psychological distress is not confined to a small proportion of pupils. Medical training can cause stress that can impact academic performance, health and coping with future clinical duties. Interventions that can be integrated into the student's routine should be considered.

Yoga is a mind-body exercise that involves physical postures, breathing exercises, relaxation and meditation. These elements could be a viable way to manage stress. Evidence from randomized trials has suggested beneficial effects of yoga on perceived stress and mood-related outcomes.^[4] A meta-analysis of physiological measures of stress also revealed that yoga and related mind-body practices may have an effect on stress-related biological responses, suggesting a potential relationship between regular yoga practice and stress regulation.^[5]

The potential value of yoga has also been explored in the context of students. Bansal *et al.* investigated the effect of a 1-month structured yoga program on 82 Indian medical students (18–23 years). They found that the intervention had a significant impact on overall and mental health.^[6] Elstad *et al.* conducted a randomized controlled trial with 202 university students, which revealed that a 12-week yoga program was effective in decreasing psychological distress compared with a wait-list control group. This improvement was still seen at follow-up.^[7] The results indicate

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that yoga is a viable option in an academic setting and can be beneficial psychologically for young adults in a challenging professional education program.

More recent studies have focused on outcomes that are very similar to those in the present study. Chauhan *et al.* evaluated depression, anxiety and stress levels using the depression anxiety stress scales-21 (DASS-21) before and after a 10-week yoga intervention in medical students. Depression and anxiety were reported as being significantly reduced.^[8] A systematic review and meta-analysis of medical and dental education then revealed that yoga interventions significantly decreased stress and anxiety. The review also noted the possible use of yoga as an adjunctive approach in medical education.^[9]

While these promising results have been found, the length of yoga interventions in student studies has been relatively brief. One-month, 10-week and 12-week programs are more frequently reported.^[6-8] There are relatively few studies on the long-term effects of yoga practice among medical students in India. Extended observation may be helpful as the psychological stress that occurs

in medical education is different for each examination, academic term, and clinical exposure.

The present study thus assessed the changes in perceived stress, depression, anxiety and stress symptoms among medical students after 1 year of regular yoga practice. The Perceived Stress Scale-10 (PSS-10) was used to measure perceived stress, and the DASS-21 were used to measure depression, anxiety, and stress symptoms. The study aimed to determine whether sustained yoga practice was associated with measurable changes in these psychological outcomes among medical students.

MATERIALS AND METHODS

Study Design and Setting

This non-randomized, single-group pre-post intervention study was conducted among medical students at M. S. Ramaiah Medical College, Bengaluru, India, from January 2020 to December 2020. Psychological outcomes were assessed at baseline and after 1 year of regular yoga practice.

The study was approved by the Institutional Ethics Committee of M. S. Ramaiah Medical College. All participants were informed about the study procedures, and written informed consent was obtained before enrolment.

Study Participants

Medical students were screened according to predefined eligibility criteria.

Inclusion Criteria

Students were eligible for participation if they:

1. Were aged 18–23 years
2. Were apparently healthy
3. Were willing to participate and practise yoga regularly; and
4. Were physically capable of performing the prescribed yoga practices.

Exclusion Criteria

Students were excluded if they:

1. Had been practising yoga, pranayama, or meditation regularly before enrolment
2. Had a history of cardiovascular disease
3. Had a history of psychiatric illness
4. Had any chronic medical illness; or
5. Reported alcohol consumption, smoking/tobacco use, or recreational drug use.

The eligibility criteria and participant-selection procedure were specified before enrolment.

Sample Size

The sample size calculation was based on previous studies where the proportion of participants in the moderate stress category reduced by 26.3% points after a yoga intervention. With an assumed difference of 26.3%, an absolute precision of 10% and a 95% confidence level, the minimum sample size was estimated to

be 74 participants. The final recruitment goal was 96 participants to account for attrition. All 96 enrolled participants completed the pre- and post-intervention assessments.

Yoga Intervention

The yoga program was structured, and participants were engaged for 1 year. The yoga session was a supervised one, about 55–60 min in duration, once a week, with a trained yoga instructor. The remaining 6 days of the week, participants were asked to follow the same routine on their own.

The yoga program included pranayama, asanas, relaxation and meditation. Pranayama consisted of Bhastrika and Kapalabhati for 10 min, Nadishodhana pranayama for 10 min and Bhramari pranayama for 6 min. The asana part included Suryanamaskar for 6 min, Padmasana or Sukhasana for 2 min, Pawanmuktasana for 4 min, Bhujangasana for 4 min, Vajrasana for 2 min and Shavasana for 6 min. There was also about 10 min of meditation during the session, focusing mainly on breathing.

Regular contact with participants was used to encourage adherence to yoga practice. Follow-up and reminders were given by telephone and electronic communication when in-person supervision was not possible.

Outcome Assessment

The primary outcomes were perceived stress and symptoms of depression, anxiety and stress. These were measured at baseline before the yoga program and after completion of the 1-year intervention with the PSS-10 and the DASS-21.

PSS-10

The PSS-10 is a 10-item self-report instrument assessing perceived stress during the preceding month. Each item is scored on a five-point response scale from 0 to 4. Positively worded items 4, 5, 7, and 8 were reverse-scored before calculation of the total score. Total PSS-10 scores range from 0 to 40, with higher scores indicating greater perceived stress.

For descriptive categorical analyses, scores were classified as:

- Low perceived stress: 0–13
- Moderate perceived stress: 14–26; and
- High perceived stress: 27–40.

DASS-21

The DASS-21 consists of 21 self-report items comprising three seven-item subscales assessing depression, anxiety, and stress. Each item is scored from 0 to 3 according to the extent to which the statement applied to the participant during the preceding week. Scores for the seven items belonging to each subscale were summed and multiplied by two to obtain the final depression, anxiety, and stress scores.

The following severity categories were used:

Severity	Depression	Anxiety	Stress
Normal	0–9	0–7	0–14
Mild	10–13	8–9	15–18
Moderate	14–20	10–14	19–25
Severe	21–27	15–19	26–33
Extremely severe	≥28	≥20	≥34

Higher DASS-21 subscale scores indicate greater symptom severity. The scoring procedure and severity categories correspond to those specified for the study.

Statistical Analysis

Continuous variables were summarized as mean $\pm$ standard deviation (SD), and categorical variables as n (%). Pre- and post-intervention PSS-10 and DASS-21 depression, anxiety, and stress scores were compared using two-sided paired Student's t -tests. The results are presented as pre- and post-intervention means with SDs, mean paired decreases with 95% confidence intervals, t statistics, degrees of freedom, and P -values.

Within-participant effect sizes were estimated using Cohen's d_z , calculated as the mean paired difference divided by the SD of the paired differences.

The distribution of paired difference scores was evaluated for normality. Wilcoxon signed-rank tests were additionally performed as sensitivity analyses to evaluate the robustness of the paired t -test findings.

PSS-10 and DASS-21 severity categories were summarized as n (%). Changes in the overall paired pre- and post-intervention categorical distributions were assessed using the Stuart–Maxwell test of marginal homogeneity. Changes in individual category proportions were expressed descriptively as percentage-point differences.

Complete paired observations were available for PSS-10, DASS-21 Depression, and DASS-21 Anxiety for 96 participants. Complete paired DASS-21 Stress observations were available for 95 participants. Analyses were conducted on available paired observations for each outcome.

All statistical tests were two-sided, and a $P < 0.05$ was considered statistically significant. Values below 0.001 were reported as $P < 0.001$.

RESULTS

A total of 96 medical students aged 18–23 years completed both the baseline and 1-year post-yoga assessments. Participant characteristics are summarized in Table 1. Paired observations were available for PSS-10, DASS-21 Depression and DASS-21 Anxiety for $n = 96$ participants, and for DASS-21 Stress for $n = 95$ participants.

Post-yoga scores were significantly lower than pre-yoga scores for PSS-10 and all three DASS-21 domains (all $P < 0.001$). The magnitude and precision of the paired changes are presented in Table 2 and Figure 1.

Categorical distributions also shifted after the intervention. Significant changes in the overall paired category distributions were observed for PSS-10, DASS-21 anxiety, and DASS-21 stress, whereas the overall change in DASS-21 depression severity categories did not reach the conventional threshold for statistical significance [Table 3]. The most prominent categorical shift occurred for anxiety, with a substantial movement toward the normal category after yoga [Figure 2].

The distribution of DASS-21 Anxiety showed the largest categorical change, with the proportion classified as normal increasing from $n = 22$ (22.9%) before yoga to $n = 68$ (70.8%) after yoga. For DASS-21 stress, the normal category increased from $n = 52$ (54.7%) to $n = 78$ (82.1%), while no participant remained in the severe category after the intervention. The corresponding

Table 1: Characteristics of the study participants

Characteristic	Study participants ($n=96$)
Age range, years	18–23
Male, n (%)	40 (41.7)
Female, n (%)	56 (58.3)
Completed pre-yoga assessment, n (%)	96 (100.0)
Completed post-yoga assessment, n (%)	96 (100.0)

Values are presented as n (%) unless otherwise indicated

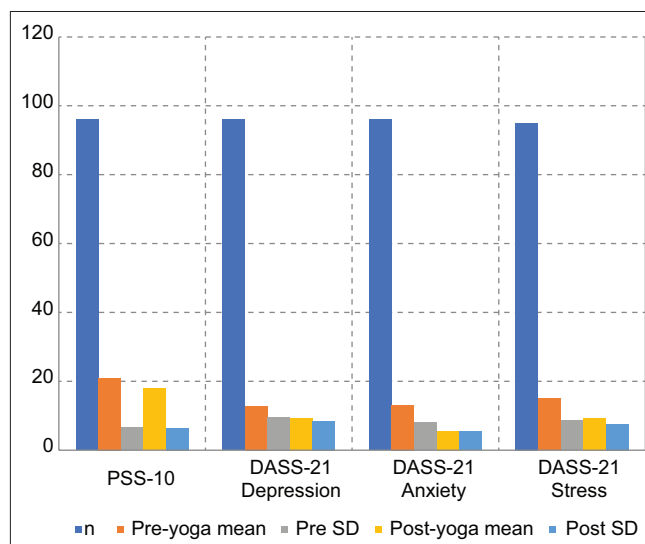


Figure 1: Mean perceived stress scale-10 (PSS-10) and depression, anxiety, and stress scales-21 (DASS-21) scores before and after 1 year of yoga. Bars represent mean scores, and error bars represent standard deviations. PSS-10, DASS-21 depression, and DASS-21 anxiety analyses included $n = 96$ participants; DASS-21 stress included $n = 95$ participants

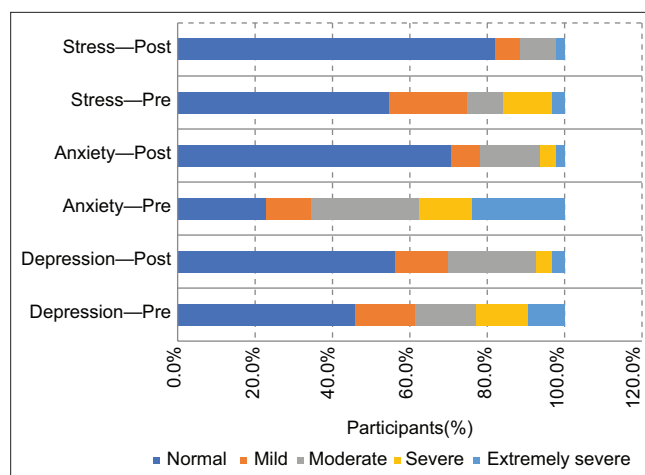


Figure 2: Distribution of depression, anxiety, and stress scales-21 severity categories before and after 1 year of yoga. Horizontal stacked bars represent the percentage of participants classified as normal, mild, moderate, severe, or extremely severe at pre-yoga and post-yoga assessment. Depression and anxiety distributions included $n = 96$ participants; Stress distributions included $n = 95$ participants

pre- and post-intervention severity distributions are illustrated in Figure 2.

Table 2: Comparison of PSS-10 and DASS-21 scores before and after yoga

Outcome	n	Pre-yoga, mean±SD	Post-yoga, mean±SD	Mean decrease (95% CI)	t (df)	P-value	Cohen's d _z
PSS-10	96	20.89±6.54	17.89±6.45	3.00 (1.77–4.23)	4.83 (95)	<0.001	0.49
DASS-21 Depression	96	12.83±9.64	9.40±8.45	3.44 (1.75–5.12)	4.05 (95)	<0.001	0.41
DASS-21 Anxiety	96	13.08±8.12	5.58±5.48	7.50 (6.01–8.99)	10.02 (95)	<0.001	1.02
DASS-21 Stress	95	15.01±8.68	9.31±7.60	5.71 (4.10–7.31)	7.07 (94)	<0.001	0.73

Values are mean±standard deviation unless otherwise indicated. Mean decrease was calculated as pre-yoga minus post-yoga score; therefore, positive values indicate lower scores after yoga. CI: Confidence interval, DASS-21: Depression anxiety stress scales-21, PSS-10: Perceived stress scale-10. P-values are from two-sided paired Student's *t*-tests. Cohen's *d* _z was calculated using the standard deviation of the paired differences

Table 3: Distribution of PSS-10 and DASS-21 severity categories before and after yoga

Outcome/category	Pre-yoga, n (%)	Post-yoga, n (%)	Change, percentage points	χ ² (df)*	P-value*
PSS-10 (n=96)					
Low (0–13)	11 (11.5)	22 (22.9)	+11.5	11.92 (2)	0.003
Moderate (14–26)	66 (68.8)	64 (66.7)	–2.1		
High (27–40)	19 (19.8)	10 (10.4)	–9.4		
DASS-21 Depression (n=96)					
Normal (0–9)	44 (45.8)	54 (56.3)	+10.4	9.40 (4)	0.052
Mild (10–13)	15 (15.6)	13 (13.5)	–2.1		
Moderate (14–20)	15 (15.6)	22 (22.9)	+7.3		
Severe (21–27)	13 (13.5)	4 (4.2)	–9.4		
Extremely severe (≥28)	9 (9.4)	3 (3.1)	–6.3		
DASS-21 Anxiety (n=96)					
Normal (0–7)	22 (22.9)	68 (70.8)	+47.9	43.21 (4)	<0.001
Mild (8–9)	11 (11.5)	7 (7.3)	–4.2		
Moderate (10–14)	27 (28.1)	15 (15.6)	–12.5		
Severe (15–19)	13 (13.5)	4 (4.2)	–9.4		
Extremely severe (≥20)	23 (24.0)	2 (2.1)	–21.9		
DASS-21 stress (n=95)					
Normal (0–14)	52 (54.7)	78 (82.1)	+27.4	21.07 (4)	<0.001
Mild (15–18)	19 (20.0)	6 (6.3)	–13.7		
Moderate (19–25)	9 (9.5)	9 (9.5)	0.0		
Severe (26–33)	12 (12.6)	0 (0.0)	–12.6		
Extremely severe (≥34)	3 (3.2)	2 (2.1)	–1.1		

*χ² statistics and P-values represent the global Stuart-Maxwell test of marginal homogeneity for the paired pre- and post-yoga category distributions.

Percentage-point change was calculated as post-yoga percentage minus pre-yoga percentage. Percentages may not total exactly 100% because of rounding

DISCUSSION

The present study revealed that medical students experienced a significant decrease in perceived stress, depression, anxiety, and stress symptoms after 1 year of regular yoga practice. The size of the change varied by outcome. The largest within-participant effect was for Anxiety (Cohen's *d* = 1.02), followed by DASS-21 stress (*d* = 0.73), PSS-10 (*d* = 0.49), and depression (*d* = 0.41). This was reflected in the categorical findings. The percentage of students identified as normal for anxiety rose from 22.9% to 70.8%, and the percentage of students identified as severe or extremely severe anxiety decreased from 37.5% to 6.3%. The percentage of participants with normal DASS-21 Stress rose from 54.7% to 82.1%, and none of the participants was in the severe stress category following the intervention. The most salient change was in anxiety and stress-related symptoms, as indicated by these findings.

This decrease in perceived stress is similar to controlled studies in university populations. Castellote-Caballero *et al.* randomly assigned 129 university students to a 12-week yoga intervention or control condition. The intervention consisted of 24, 60-min, supervised sessions. Yoga had a medium effect size (*d* = 0.44) on perceived stress. Emotional well-being also improved (*d* = 0.47), and effects were seen for both state anxiety (*d* = 0.38) and trait anxiety (*d* = 0.80).^[10] Our estimate of the PSS-10 effect (*d* = 0.49) is comparable in magnitude, but caution is needed in comparing

directly with the comparator study, as that study estimated the effects of controlled interventions.

Chang *et al.* offer additional confirmation in a much larger randomized sample. In their wait-list crossover trial, the 679 undergraduate students were asked to perform online Isha Upa Yoga for 12 weeks every day. In the first 4-week randomized period, yoga was effective in reducing stress (*P* = 0.009; *d* = 0.27) and enhancing well-being (*P* = 0.002; *d* = 0.32) compared to control. At the end of the study, there was also a significant improvement in anxiety and depression following the intervention.^[11] The greater anxiety response in our group could be due to the longer intervention period, the use of asanas, pranayama, relaxation, and meditation, or to variations in the severity of symptoms at baseline. However, it should not be read as an indication of higher effectiveness, as we did not have a concurrent control group.

The PSS-10 results can also be compared to those of Lemay *et al.* They conducted a 6-week pilot program with 17 college students (ages 19–23) and used a weekly 60-min yoga class along with guided meditation. The mean scores of the PSS decreased by 7.9 points, and the mean scores of the Beck Anxiety Inventory decreased by 9.6 points. There were categorical changes in perceived stress (*P* = 0.03) and anxiety (*P* = 0.008), and no one was in the high stress or high anxiety group at the end of the program.^[12] We had a smaller mean PSS-10 reduction (3.00 points), but in a much larger sample and over a year. Importantly, the mean

score of the PSS-10 post intervention in our study was not outside of the moderate range. This suggests that there is a reduction, but not an elimination, of perceived stress and is possible in the on-going context of medical education.

The evidence in particular that relates to Indian medical students is relevant. Sunita *et al.* recruited 105 1st-year female medical students and randomly assigned them to one of four groups: Meditation, pranayama, yoga, and a control group that did not practise meditation, pranayama, or yoga, and then compared these groups for 12 weeks. The participants trained for 6 days a week for 40 min. Median anxiety scores in the yoga group decreased from 39 to 31 at 12 weeks, and median depression scores decreased from 7 to 3 at 12 weeks. The improvements were ongoing from 6 to 12 weeks, and yoga had the largest overall reduction in anxiety and depression of the three active interventions.^[13] We have extended these observations to include male and female medical students and to a much longer period. The consistent decrease in all four psychological outcomes at 1 year is consistent with the potential for on-going practice to maintain psychological benefits beyond the brief intervention durations typically examined.

It is important to consider the present findings in the context of not all controlled studies showing clear group-level effects. Papp *et al.* divided 44 healthy students into two groups: One that participated in a 6-week high-intensity Hatha yoga program and a control group. One weekly class and recommended home practice. The between-group differences were not significant for anxiety, depression, perceived stress, sleep, and self-rated health. However, within the yoga group, higher yoga exposure was correlated with improvement in depression ($r = 0.47$, $P = 0.03$), sleep quality ($r = 0.55$, $P = 0.01$) and insomnia ($r = 0.49$, $P = 0.02$).^[14] This finding is important to our intervention because participants also had supervised sessions with regular home practice. It implies that intervention exposure and adherence could be a factor in outcomes. In our study, daily practice was encouraged, but there was not enough detail of adherence to quantify a dose-response relationship.

Psychobiological evidence also supports the particularly large change in anxiety that we observed in our study. Pal *et al.* randomly assigned 73 stressed college students to Mano Shakti Yoga or a no-yoga control, and 42 of them finished both tests. The program consisted of 12 sessions, 6 weeks. The yoga group had significantly lower anxiety scores than the controls ($F = 28.779$, $P < 0.001$) and depression scores ($F = 9.846$, $P = 0.003$) after intervention. Furthermore, salivary cortisol significantly decreased following yoga ($P < 0.01$) but not in controls ($P = 0.60$).^[15] The cortisol change that accompanied this psychological improvement reinforces the interpretation that it is possible to have measurable physiological changes in response to stress while also improving psychologically. Biological markers were not assessed in our study, and therefore, the mechanisms responsible for the DASS-21 and PSS-10 changes observed cannot be determined.

There is less evidence of longer duration, which provides a valuable comparison to the current 1-year intervention. Recently, Singh *et al.* studied a 6-month structured yoga intervention in 158 undergraduate healthcare students, divided into two groups: 78 students who received yoga and 80 sex-matched students who were controls. There were no significant differences between groups in baseline characteristics. The yoga group experienced a significant improvement in psychological well-being and perceived stress ($P < 0.001$ for both) after 6 months, while the

control group experienced a deterioration in psychological well-being ($P < 0.001$) and no significant change in perceived stress ($P = 0.106$). Between-group comparisons favoured the yoga group for both outcomes ($P < 0.001$).^[16] These findings are especially important as they include healthcare students and a longer exposure time. We expanded the observation period to 1 year and evaluated perceived stress, depression, anxiety and stress symptoms concurrently.

One of the interesting findings of the present study was the difference between continuous and categorical analysis of depression. The mean DASS-21 depression scores were significantly reduced from 12.83 to 9.40 ($P < 0.001$) with a small to moderate effect size ($d_z = 0.41$). The overall redistribution across depression severity categories was not statistically significant at the conventional level ($P = 0.052$). Nevertheless, the normal category increased from 45.8% to 56.3%, while severe depression decreased from 13.5% to 4.2% and extremely severe depression from 9.4% to 3.1%. This seemingly contradictory difference is not a contradiction. Categorization discards information in continuous scores and only shows a change in category-based analysis when participants cross thresholds. The finding thus indicates a general decrease in depressive symptom burden, but not equally strong evidence of a redistribution across all five severity strata.

The study has several strengths. The length of 1 year is significantly longer than the interventions in many comparator studies, which range from 6 to 12 weeks.^[10-15] The intervention also included some of the traditional elements of yoga such as asana, pranayama, relaxation and meditation. Both the PSS-10 and DASS-21 were used to assess psychological outcomes, enabling the examination of perceived stress in addition to depression, anxiety, and stress symptoms. In addition to statistical significance, effect sizes were reported, and categorical transitions were reported to provide clinically interpretable information beyond mean score changes. Completion was high, with paired observations for all 96 participants for PSS-10, Depression, and Anxiety and for 95 participants for DASS-21 stress.

The results should be interpreted based on the study design. There is no randomized control group to draw causal conclusions, and changes over time may have been driven by academic pressures or the COVID-19 pandemic. Self-reported outcomes, no objective measurement of adherence to home practice, and no separation of the contribution of individual components of yoga. The single-center sample of apparently healthy medical students also restricts generalizability. However, the steady decrease in all PSS-10 and DASS-21 scores, especially for anxiety and stress, indicates that long-term yoga practice could be beneficial as a complementary therapy. Future randomized studies with objective adherence monitoring and longer follow-up are needed to confirm these findings.

CONCLUSION

Medical students who practiced yoga regularly for 1 year showed significant decreases in perceived stress, depression, anxiety and stress symptoms. The greatest change was seen for anxiety, followed by stress, and there were also meaningful decreases in perceived stress and depression. The categorical shifts toward normal anxiety and stress levels further support the possible benefits of continued yoga practice as a supportive tool for psychological health in medical students. The results should be interpreted cautiously because of the single-group design and

lack of a control group. Further randomized controlled trials are warranted to confirm these findings and determine the importance of long-term adherence.

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