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The effects of Transcendental Meditation on emotional intelligence, stress, fatigue, and sleep quality among Ayurvedic medical students in India

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Introduction: Emotional intelligence (EI) is essential for resilience and adaptability in high-pressure environments such as medical education. Transcendental Meditation (TM) has been shown to enhance emotional regulation, reduce stress, and improve wellbeing. This quasi-experimental, longitudinal observational study evaluated the effects of TM on emotional intelligence, perceived stress, fatigue, and sleep quality among Ayurvedic medical students over a 6-month period.

Methods: This study included 176 Ayurvedic medical students at D. Y. Patil College of Ayurved and Research Center of Dr. D. Y. Patil Vidyapeeth (Deemed to be University) in India, comprising a TM group ($n = 97$) and a control group ($n = 79$). Global Emotional Intelligence (Global EI) and its subdomains (Wellbeing, Emotionality, Self-Control, and Sociability) were assessed using the Trait Emotional Intelligence Questionnaire, Short Form (TEIQue-SF). Secondary outcomes included perceived stress (Perceived Stress Scale; PSS), fatigue (PROMIS Fatigue Short Form), and insomnia severity (Insomnia Severity Index; ISI). Assessments were conducted at baseline, 3 months, and 6 months. Linear mixed-effects models (LMMs) were used to evaluate *Group* × *Time* interactions for each outcome, controlling for age. An autoregressive [AR(1)] covariance structure was specified to account for repeated measures. Pairwise comparisons based on estimated marginal means were used to assess between-group differences at each timepoint.

Results: Significant *Group* × *Time* interactions were observed for Global Emotional Intelligence (EI) ($p < 0.001$), perceived stress ($p < 0.001$), fatigue ($p < 0.001$), and insomnia severity ($p < 0.001$), indicating that the TM and control groups showed different patterns of change over time. Specifically, the TM group demonstrated substantial improvements in Global EI and significant reductions in perceived stress, fatigue, and insomnia severity by 6 months compared to the control group. Secondary analyses also revealed significant *Group* × *Time* interactions across all four Global EI subdomains (Wellbeing, Emotionality, Self-Control, and Sociability; all $p < 0.001$).

Conclusion: Regular practice of Transcendental Meditation (TM) led to meaningful improvements in emotional intelligence, reductions in perceived

stress and fatigue, and enhanced sleep quality among Ayurvedic medical students. These findings support integrating TM into student wellness programs as an effective strategy for promoting psychological resilience in high-stress academic environments.

KEYWORDS

Transcendental Meditation, emotional intelligence, stress reduction, fatigue, sleep quality, Ayurveda medical students, consciousness-based education

1 Introduction

Emotional intelligence (EI), the ability to perceive, understand, manage, and regulate emotions, is a crucial skill in high-pressure environments such as medical education (Goleman, 1995; Salovey and Sluyter, 1997). Research indicates that higher EI is linked to improved cognitive flexibility, emotional regulation, and stronger interpersonal relationships, all of which contribute to academic and professional success (Brackett et al., 2011; Schutte and Malouff, 2011). Medical students with higher EI tend to demonstrate better decision-making, communication skills, and adaptability, qualities that are essential for clinical performance and patient care (Arora et al., 2010; Cherry et al., 2014; Weng et al., 2011). However, while EI can be cultivated through training and experience, the rigorous demands of medical education often limit opportunities for its development (Arora et al., 2011; Dyrbye et al., 2005; Nelis et al., 2009).

Many students in medical training struggle with emotional regulation and self-awareness due to intensive workloads, high-stakes assessments, and clinical responsibilities (Fares et al., 2016; Ishak et al., 2013; Kumar et al., 2016). These pressures have been shown to negatively affect emotional processing, decision making, and interpersonal functioning, underscoring the need for structured interventions that support the development of EI (Zeidner et al., 2011). Meditation-based practices, in particular, have been shown to improve self-regulation, emotional awareness, and cognitive resilience (Schutte and Malouff, 2011; Valosek et al., 2018).

One such intervention is Transcendental Meditation (TM), a widely studied automatic self-transcending technique shown to enhance emotional processing and interpersonal awareness (Orme-Johnson and Barnes, 2014; Travis et al., 2009). Unlike focused attention and open monitoring mindfulness techniques, which often require sustained cognitive effort and active attention regulation (Tang et al., 2015; Sharma and Rush, 2014), TM facilitates a state of effortless awareness without concentration or monitoring (Travis and Shear, 2010). This distinction may be particularly important for individuals experiencing high levels of fatigue or stress, such as medical students, for whom an effortless approach to self-regulation could be more accessible and sustainable (Orme-Johnson and Barnes, 2014).

Beyond its effortless practice, neurophysiological studies suggest that long-term TM practitioners may exhibit increased neural efficiency in the prefrontal cortex, a brain region responsible for emotional regulation and social cognition (Travis et al., 2009; Wallace and Wallace, 2021). TM has also been shown to promote greater emotional stability and reduce psychological distress across diverse populations, including college students, administrators, and staff (Nidich et al., 2009; MacLean et al., 1997; Orme-Johnson and Barnes, 2014; Valosek et al., 2018).

Although TM has been widely studied across various populations, including college students and healthcare professionals, no published studies to date have examined its effects specifically among Ayurvedic medical students. This population faces unique academic, clinical, and cultural pressures, making it important to explore interventions that could support their emotional resilience and psychological wellbeing. Given these considerations, the present study aims to evaluate the effects of TM on emotional intelligence among Ayurvedic medical students in India, specifically assessing changes in Global EI and its subdomains: Wellbeing (reflecting optimism, happiness, and general life satisfaction), Emotionality (the ability to perceive and express emotions and maintain close relationships), Self-Control (the capacity to regulate impulses, stress, and emotional reactions), and Sociability (confidence in social interactions and the ability to influence others) (Petrides, 2009; Petrides et al., 2010).

Additionally, this research examines the impact of TM on perceived stress, fatigue, and insomnia severity to determine whether TM practice supports resilience and overall wellbeing in medical students. By providing evidence-based insights into the relationship between TM and EI in a medical education context, this study seeks to inform the development of TM-based interventions for student wellness programs and professional development.

2 Methods

2.1 Study design

This study employed a quasi-experimental, longitudinal observational design to evaluate changes in emotional intelligence (EI), perceived stress, fatigue, and insomnia severity over a 6-month period among Ayurvedic medical students ($N = 176$). A quasi-experimental design was selected due to the natural assignment of students based on academic program enrollment, which precluded randomization but allowed for real-world evaluation of the TM intervention's effects over time.

Participants were divided into two groups based on program enrollment: a Transcendental Meditation (TM) group ($n = 97$), who received TM instruction and incorporated daily practice into their curriculum, and a control group ($n = 79$), who continued with standard coursework without TM instruction. Data were collected at baseline, 3 months, and 6 months.

The primary outcome was change in Global EI, while secondary outcomes included perceived stress, fatigue, and insomnia severity. Linear mixed-effects models (LMMs) with an autoregressive covariance structure [AR(1)] were used to examine *Group* × *Time* interactions, evaluating differential changes in outcomes over time between the TM and control groups. All models controlled for age as a covariate. Baseline group characteristics were summarized using estimated marginal means. Although some between-group differences were observed at baseline, these were addressed analytically by modeling time as a repeated measure and including age as a covariate in all models.

2.2 Participants

Participants were enrolled in Ayurvedic medical programs at Dr. D. Y. Patil College of Ayurved and Research Center of Dr. D. Y. Patil Vidyapeeth (Deemed to be University), Pimpri, Pune, India. The TM group comprised of students newly admitted to the Bachelor of Ayurvedic Medicine and Surgery (B.A.M.S.) program with no prior exposure to Transcendental Meditation. The control group consisted of students enrolled in the Doctor of Ayurvedic Medicine and Master of Surgery [M.D./M.S. (Ayurved)] program, representing a more advanced stage of medical education. Although both groups shared the same institutional setting and academic focus in Ayurvedic medicine, differences in academic seniority were addressed statistically by including age as a covariate in all outcome analyses, and potential differences are further discussed in the study limitations.

Some participants in the control group reported prior experience with contemplative practices such as yoga or mindfulness through academic training or personal interest, although none received TM instruction. This prior exposure may have influenced baseline characteristics or psychological outcomes and is noted as a limitation of the study.

Inclusion criteria required enrollment in either the B.A.M.S. or M.D./M.S. (Ayurved) programs and willingness to participate in a 6-month study involving repeated assessments. Students with previous experience in TM were excluded from participation.

2.2.1 Intervention group

The intervention group consisted of B.A.M.S. students who received instruction in TM through a structured training program conducted by certified TM teachers. Certified TM teachers are professionals who have completed an intensive, standardized teacher training course administered by the official TM organization. This certification ensures they are qualified to provide individualized instruction in the TM technique and uphold the consistency, safety, and integrity of the teaching process worldwide. The core TM training included four instructional sessions. Following this, participants practiced TM in a group setting twice daily in their classroom, 6 days a week, and independently on Sundays and holidays as part of their regular academic schedule for the duration of the study. The intervention was outlined as follows.

2.2.1.1 Personal instruction (day 1)

Participants received one-on-one personal instruction from a certified TM teacher. During this session, which lasted ∼1–2 h, participants were taught the TM technique, including their individualized mantra. The personal nature of this session ensured that each participant was introduced to the practice in a manner tailored to their specific needs.

2.2.1.2 First follow-up (day 2)

On the second day, participants attended a group follow-up session lasting 1–2 h. The purpose of this session was to verify that participants were practicing the technique correctly.

Participants had the opportunity to share their experiences from the first session, and the teacher provided feedback and additional guidance as needed to ensure that the TM technique was being practiced effortlessly.

2.2.1.3 Second follow-up (day 3)

The third session, conducted in a group format, took place on the third day. This session reviewed the mechanics of the TM technique in greater detail and provided further insights into how the practice affects the mind and body. This session lasted ∼1–2 h and deepened participants' understanding of the process and benefits of meditation.

2.2.1.4 Third follow-up (day 4)

The final session, also conducted in a group setting, occurred on the fourth day. This session reviewed the benefits of regular TM practice and its implications for long-term mental and physical wellbeing. Additionally, the instructor verified that participants were practicing the technique correctly, ensuring that they were positioned for sustained success with the practice.

2.2.1.5 Twice daily practice

Throughout the duration of the study, participants in the intervention group practiced TM twice daily as a group in their classroom setting. Each meditation session lasted ∼20 min and was conducted in the morning and afternoon, 6 days a week. On Sundays and holidays, when students were not attending classes, they were instructed to continue practicing TM twice daily on their own.

To ensure compliance, certified TM teachers regularly checked in with the students during non-school days through phone calls, messages, or virtual meetings, providing support and guidance to maintain adherence to the meditation schedule. Professors from D. Y. Patil College of Ayurved and Research Center of Dr. D. Y. Patil Vidyapeeth (Deemed to be University), Pimpri, Pune, India, along with TM teachers, provided ongoing encouragement and monitored adherence to the participants' meditation practice.

In addition to these measures, classroom attendance during scheduled TM sessions was systematically recorded by faculty throughout the intervention period. Attendance served as a proxy for monitoring supervised TM compliance during class hours.

2.2.2 Control group

Participants in the control group were from the B.A.M.S. M.D./M.S. (Ayurved) program and did not receive TM training. They continued with their usual daily routines without any

structured intervention, which included attending their regular academic activities, studying, and engaging in personal routines.

2.3 Assessment and data collection

The intervention and control groups were assessed at the same time points: baseline, 3 months, and 6 months, using the same measurement instruments to ensure consistency in data collection and analysis (see Figure 1).

Emotional intelligence was measured using the Trait Emotional Intelligence Questionnaire–Short Form (TEIQue-SF), a 30-item self-report instrument designed to assess global trait emotional intelligence and four subdomains: Wellbeing (optimism, happiness, and life satisfaction), Emotionality (emotional expression and relationship capacity), Self-Control (emotion regulation and impulse control), and Sociability (social confidence and influence). Items are rated on a 7-point Likert scale ranging from 1 (completely disagree) to 7 (completely agree), with higher scores indicating greater emotional intelligence. Global EI is calculated by averaging responses across all 30 items, while subdomain scores are derived by averaging the items corresponding to each specific domain. The TEIQue-SF has demonstrated strong psychometric properties across cultural and educational contexts, including university student populations (Siegling et al., 2015). In the present study, the TEIQue-SF demonstrated good internal consistency, with Cronbach's alpha ranging from 0.76 to 0.89, and a test-retest reliability of 0.78 (Petrides, 2009).

Secondary measures included perceived stress, fatigue, and sleep problems.

Perceived stress was assessed using the Perceived Stress Scale (PSS-10), a 10-item self-report questionnaire that evaluates the degree to which individuals appraise situations in their lives as stressful, unpredictable, or overwhelming over the past month. Items reflect feelings of being unable to control or cope with demands, and responses are rated on a 5-point Likert scale ranging from 0 (never) to 4 (very often). Total scores range from 0 to 40, with higher scores indicating greater perceived stress. The PSS has demonstrated strong internal consistency, with Cronbach's alpha ranging from 0.84 to 0.86 (Cohen et al., 1983).

Fatigue was measured using the Patient-Reported Outcomes Measurement Information System (PROMIS) Fatigue Short Form 8a, which consists of eight items designed to assess the impact and experience of fatigue over the past 7 days. Items cover both physical and mental aspects of fatigue, such as energy levels, tiredness, and difficulty initiating activities. Responses are rated on a 5-point Likert scale from 1 (not at all) to 5 (very much). Higher scores indicate greater fatigue. The PROMIS Fatigue Short Form has demonstrated excellent internal consistency, with Cronbach's alpha values typically reported as >0.90 (Cella et al., 2010).

Sleep problems were assessed using the Insomnia Severity Index (ISI), a 7-item instrument that evaluates the nature, severity, and impact of insomnia symptoms experienced over the previous 2 weeks. Items address difficulties with sleep onset, sleep maintenance, early morning awakening, dissatisfaction with sleep, interference with daily functioning, noticeability of sleep problems, and distress caused by insomnia. Each item is rated on a 5-point Likert scale from 0 to 4, with total scores ranging from 0 to 28. Higher scores reflect more severe insomnia. The ISI has shown strong internal consistency (Cronbach's alpha = 0.91) and good test–retest reliability ($r = 0.86$) (Morin et al., 2011).

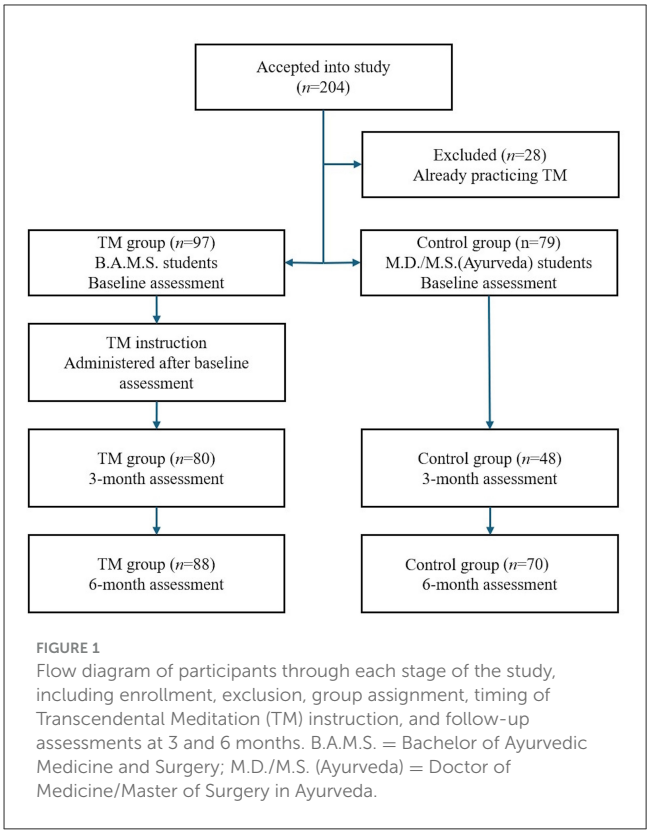

FIGURE 1
Flow diagram of participants through each stage of the study, including enrollment, exclusion, group assignment, timing of Transcendental Meditation (TM) instruction, and follow-up assessments at 3 and 6 months. B.A.M.S. = Bachelor of Ayurvedic Medicine and Surgery; M.D./M.S. (Ayurveda) = Doctor of Medicine/Master of Surgery in Ayurveda.

Data were collected electronically using Google Forms under supervised conditions to ensure standardization. Supervision was limited to allocating classroom time for survey completion and did not involve any interaction with or influence on student responses.

2.4 Data privacy and protection

This study adhered to India's Digital Personal Data Protection Act, 2023, and relevant U.S. data protection standards, including applicable federal and state privacy regulations. These frameworks emphasize consent-based data collection, purpose specification, data minimization, transparency, individual rights (e.g., access, correction, and erasure), and breach notifications.

2.5 Statistical analysis

Baseline demographic characteristics, including gender, nationality, and primary language spoken (English, Hindi, Marathi, or other), were summarized using frequencies and percentages. Group differences for categorical variables were assessed using chi-square tests. Age was compared between groups using independent samples *t*-tests (see Table 1).

TABLE 1 Participants demographics at baseline.

Variable	Control ($n = 79$)		TM ($n = 97$)		p-Value
	Mean (*SD*)	*n* (%)	Mean (*SD*)	*n* (%)	
Age	25.68 (1.62)		19.65 (2.18)		<0.001
Gender (female)		51 (61.4%)		71 (68.9%)	0.445
Nationality (Indian National)		79 (95.2%)		97 (94.2%)	0.762
Primary language spoken					0.359
English		5 (6.0%)		9 (8.7%)	
Hindi		20 (24.1%)		15 (14.6%)	
Marathi		49 (59%)		70 (68%)	
Other		5 (6.0%)		3 (2.9%)	

TM, transcendental meditation; SD, standard deviation; n, number of subjects.

To evaluate changes in emotional intelligence (EI), perceived stress, fatigue, and insomnia severity over time, linear mixed-effects models (LMMs) were conducted for each outcome. Each model included fixed effects for group (TM vs. control), timepoint (baseline, 3 months, and 6 months), and their interaction (*Group* × *Time*). Age was included as a covariate to adjust for baseline demographic differences. An autoregressive [AR(1)] covariance structure was applied to model temporal autocorrelation among repeated measures. Differences between groups at baseline for primary and secondary outcomes were not directly tested, consistent with the longitudinal analytic framework focusing on trajectories of change over time.

Global Emotional Intelligence (Global EI) was designated as the primary outcome. Perceived stress, fatigue, and insomnia severity were treated as secondary outcomes, and the four subdomains of Global EI (Wellbeing, Emotionality, Self-Control, and Sociability), as measured by the TEIQue-SF, were evaluated as exploratory outcomes. LMMs were run independently for each outcome. A Bonferroni correction was applied to the exploratory subdomain analyses to adjust for multiple comparisons, setting the significance threshold at $p < 0.0125$. No correction was applied to Global EI or the secondary outcomes, which were analyzed independently based on their distinct theoretical constructs and their pre-specified roles in the study.

Linear mixed-effects models (LMMs) were selected for their ability to handle missing data under the assumption that data were missing at random (MAR), to include all available observations without listwise deletion, and to better accommodate the correlated structure of repeated measures compared to ANCOVA and repeated measures ANOVA. This approach provided more efficient and less biased estimates of group differences over time. Repeated measures were modeled using an autoregressive [AR(1)] covariance structure to account for temporal correlations within subjects. Degrees of freedom for fixed effects were estimated using the Satterthwaite approximation to provide more accurate significance testing in the presence of unequal group sizes and missing observations.

Estimated marginal means (EMMs), standard errors (SEs), and 95% confidence intervals (CIs) were reported for each group at each timepoint. Where a significant *Group* × *Time* interaction was observed, between-group differences were interpreted at the follow-up assessments (3 and 6 months). Effect sizes were calculated using Cohen's *d*, based on model-derived adjusted means and pooled residual standard deviations. Assumption checks for the linear mixed models indicated no significant violations; detailed diagnostics are available upon request.

All analyses were conducted using IBM SPSS Statistics (version 26; IBM Corp, 2021). Statistical significance was defined as $p < 0.05$ unless otherwise corrected for multiple comparisons.

3 Results

3.1 Demographic characteristics by group

A total of $N = 176$ students participated in the study ($n = 97$ TM group; $n = 79$ control group). Baseline demographic characteristics are presented in Table 1. The two groups were comparable across most demographic variables, with no significant differences in gender distribution (female: 68.9% TM, 61.4% control; $p = 0.445$), nationality (Indian: 94.2% TM, 95.2% control; $p = 0.762$), or primary language spoken ($p = 0.359$). Language distribution included English (TM: 8.7%, control: 6.0%), Hindi (TM: 14.6%, control: 24.1%), Marathi (TM: 68.0%, control: 59.0%), and other languages (TM: 2.9%, control: 6.0%). However, the TM group was significantly younger than the control group (TM: $M = 19.65$, $SD = 2.18$; control: $M = 25.68$, $SD = 1.62$; $p < 0.001$). As a result, age was included as a covariate in all outcome analyses.

3.2 Study outcomes

Attendance at TM sessions during scheduled class times was monitored throughout the study as a proxy for supervised practice compliance. Monthly attendance rates among TM participants ranged from 74.0% to 90.3% across the 6-month intervention period, with the highest attendance observed during the initial months.

3.3 Global emotional intelligence

A linear mixed-effects model revealed a significant main effect of Group, $F_{(1,217)} = 18.83$, $p < 0.001$, and a significant effect of Time, $F_{(2,286)} = 4.13$, $p = 0.017$. Most importantly, there was a significant *Group* × *Time* interaction, $F_{(2,286)} = 32.38$, $p < 0.001$, indicating that changes in Global Emotional Intelligence over time differed between the TM and control groups. Age was also a significant covariate, $F_{(1,210)} = 5.78$, $p = 0.017$, and was included to adjust for group differences (see Table 2).

Estimated marginal means and pairwise comparisons are presented in Table 3. At baseline, Global EI scores were similar between the TM group [$M = 4.69$, $SE = 0.10$, 95% CI (4.23, 4.72)] and the control group [$M = 4.47$, $SE = 0.13$, 95% CI (4.49, 4.88)], $p = 0.271$. At 3 months, the TM group scored significantly higher [$M = 5.10$, $SE = 0.10$, 95% CI (4.89, 5.30)] than the control group [$M = 4.19$, $SE = 0.14$, 95% CI (3.92, 4.46)], $p < 0.001$, with a large effect size ($d = 1.18$). At 6 months, the TM group's scores continued to increase [$M = 5.42$, $SE = 0.11$, 95% CI (5.19, 5.59)] compared to the control group [$M = 4.13$, $SE = 0.13$, 95% CI (3.88, 4.38)], $p < 0.001$, with a very large effect size ($d = 1.67$) (see Figure 2).

These results demonstrate that participation in the TM program was associated with significant and sustained improvements in Global Emotional Intelligence over 6 months, relative to controls.

3.4 Emotional intelligence subdomains

Secondary analyses were conducted on the four subdomains of Global Emotional Intelligence: Wellbeing, Emotionality, Self-Control, and Sociability. Linear mixed models indicated statistically significant *Group* × *Time* interaction effects for all four subdomains. Specifically, the interaction was significant for Wellbeing, $F_{(2,287)} = 26.05$, $p < 0.001$; Emotionality, $F_{(2,296)} = 17.61$, $p < 0.001$; Self-Control, $F_{(2,291)} = 18.57$, $p < 0.001$; and Sociability, $F_{(2,295)} = 15.63$, $p < 0.001$ (see Appendix Tables A1, A2).

Mirroring the findings for Global Emotional Intelligence, participants in the TM group demonstrated significantly greater improvements across all four subdomains relative to the control group. A Bonferroni-adjusted threshold of $p < 0.0125$ was applied to account for multiple comparisons, and all interaction effects remained statistically significant.

Although both Tables A1, A2 include *p*-values, they reflect distinct statistical tests. Table A1 reports the interaction term from the full linear mixed model, assessing whether changes over time differ between groups. Table A2 presents pairwise comparisons between groups at each individual timepoint. The consistency of findings across both tables supports the robustness of the observed effects.

These results suggest that the TM intervention produced reliable and domain-specific improvements in emotional functioning, complementing the broader enhancement of Global Emotional Intelligence.

TABLE 2 Fixed effects from linear mixed models for global emotional intelligence, perceived stress, fatigue, and insomnia.

Outcome	Effect	Degrees of freedom (numerator)	Degrees of freedom (denominator)	*F*-Value	*p*-Value
Global EI	Group	1	217	18.83	<0.001
	Time	2	286	4.13	0.017
	Group × time	2	286	32.38	<0.001
	Age	1	210	5.78	0.017
Perceived stress	Group	1	216	10.28	0.002
	Time	2	285	3.39	0.035
	Group × time	2	285	25.72	<0.001
	Age	1	208	3.86	0.051
Fatigue	Group	1	224	8.35	0.004
	Time	2	293	3.21	0.042
	Group × time	2	292	21.45	<0.001
	Age	1	215	0.83	0.364
Insomnia	Group	1	227	2.64	0.105
	Time	2	295	0.04	0.963
	Group × time	2	295	12.74	<0.001
	Age	1	218	0.22	0.639

Degrees of freedom, F-values, and p-values reflect results from Type III tests of fixed effects in linear mixed models using restricted maximum likelihood estimation. Cohen's d values were calculated using estimated marginal means and the model residual standard deviation.

TABLE 3 Estimated marginal means and effect sizes for outcome measures at each timepoint.

Outcome	Timepoint	TM mean (*SE*)	Control mean (*SE*)	TM 95% CI	Control 95% CI	*p*-Value	Cohen's *d*
Global EI	Baseline	4.69 (0.10)	4.47 (0.13)	[4.23, 4.72]	[4.49, 4.88]	0.271	
	3 months	5.10 (0.10)	4.19 (0.14)	[4.89, 5.3]	[3.92, 4.46]	<0.001	1.18
	6 months	5.42 (0.11)	4.13 (0.13)	[5.19, 5.59]	[3.88, 4.38]	<0.001	1.67
Perceived stress	Baseline	18.17 (0.74)	19.01 (0.94)	[16.70, 19.63]	[17.17, 20.86]	0.556	
	3 months	16.31 (0.79)	20.16 (1.03)	[14.76, 17.87]	[18.13, 22.19]	0.013	−0.66
	6 months	12.97 (0.80)	21.51 (0.96)	[11.4, 14.54]	[19.61, 23.4]	<0.001	−1.46
Fatigue	Baseline	17.10 (0.98)	17.01 (1.23)	[15.18, 19.02]	[14.59, 19.42]	0.961	
	3 Months	12.43 (1.05)	18.42 (1.39)	[10.37, 14.50]	[15.72, 19.02]	0.003	−0.77
	6 Months	10.75 (1.06)	20.31 (1.26)	[8.66, 12.83]	[17.82, 22.80]	<0.001	−1.23
Insomnia severity	Baseline	8.12 (0.72)	7.25 (0.90)	[6.70, 9.54]	[5.47, 9.02]	0.528	
	3 Months	6.36 (0.77)	9.12 (1.02)	[4.84, 7.88]	[7.12, 11.11]	0.067	−0.48
	6 Months	5.57 (0.78)	10.10 (0.93)	[4.03, 7.10]	[8.27, 11.93]	0.002	−0.79

Sample sizes vary by timepoint. TM group: Baseline (n = 97), 3M (n = 80), 6M (n = 88); Control group: Baseline (n = 79), 3M (n = 79), 6M (n = 70). TM Mean (SE) and Control Mean (SE) reflect estimated marginal means and standard errors from the linear mixed-effects models. p-values reflect between-group comparisons at each timepoint based on pairwise comparisons. Cohen's d values were calculated using adjusted means and the model residual standard deviation at each timepoint.

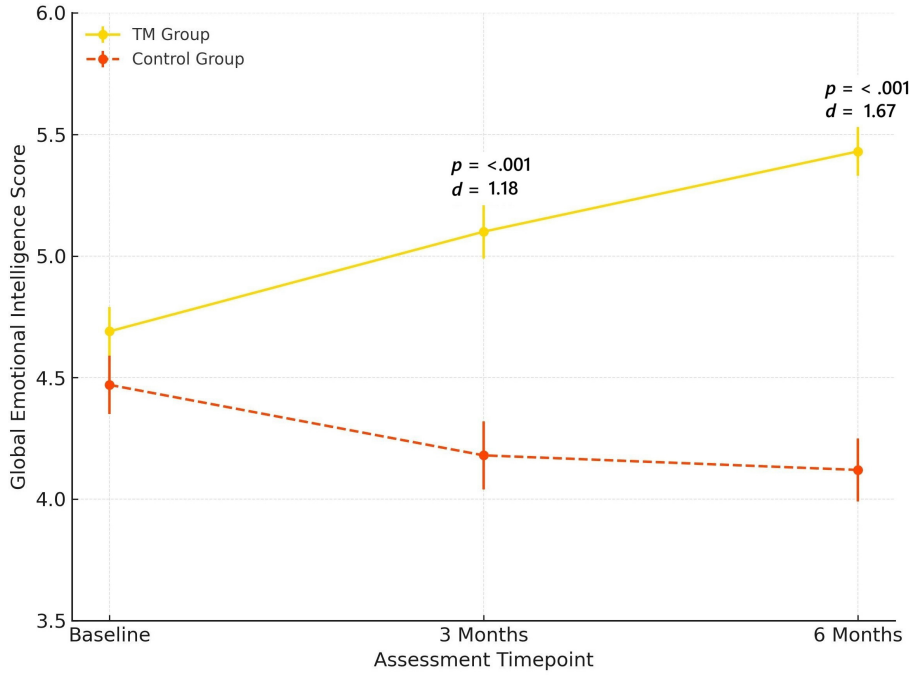

FIGURE 2
Trajectories of Global Emotional Intelligence (Global EI) scores from baseline to 6 months in the Transcendental Meditation (TM) group and control group. Error bars represent ±1 standard error. Between-group differences at 3 and 6 months are annotated with *p*-values and corresponding Cohen's *d* effect sizes.

3.5 Perceived stress

A significant *Group* × *Time* interaction was observed, $F_{(2,285)} = 25.72$, $p < 0.001$, indicating that changes in perceived stress differed between groups over time, with the TM group showing greater reductions. Significant main effects were also found for Group, $F_{(1,216)} = 10.28$, $p = 0.002$, and Time, $F_{(2,285)} = 3.39$, $p = 0.035$. Age was not a significant covariate, $F_{(1,208)=} 3.86$, $p = 0.051$, but was included in the model to adjust for potential confounding (see Table 2).

Estimated marginal means are reported in Table 3. At baseline, the TM group reported slightly lower stress levels [$M = 18.17$, $SE = 0.74$, 95% CI (16.70, 19.63)] compared to the control group [$M = 19.01$, $SE = 0.94$, 95% CI (17.17, 20.86)], $p = 0.556$. At 3 months,

stress was significantly lower in the TM group [$M = 16.31$, $SE = 0.79$, 95% CI (14.76, 17.87)] than in the control group [$M = 20.16$, $SE = 1.03$, 95% CI (18.13, 22.19)], $p = 0.013$, with an effect size of $d = -0.66$. At 6 months, the TM group continued to improve [$M = 12.97$, $SE = 0.80$, 95% CI (11.4, 14.54)] while the control group worsened [$M = 21.51$, $SE = 0.96$, 95% CI (19.61, 23.4)], $p < 0.001$, $d = -1.46$. These results indicate a substantial and sustained reduction in stress among TM participants.

3.6 Fatigue

A significant *Group* × *Time* interaction was found, $F_{(2,292)} = 21.45$, $p < 0.001$, suggesting differential changes in fatigue levels between the TM and control groups. A main effect of Group was also observed, $F_{(1,224)} = 8.35$, $p = 0.004$, and the main effect of Time was significant, $F_{(2,293)} = 3.21$, $p = 0.042$. Age was not a significant covariate, $F_{(1,215)} = 0.83$, $p = 0.364$, but was controlled in the model (see Table 2).

As shown in Table 3, both groups began with comparable levels of fatigue at baseline (TM: $M = 17.10$, $SE = 0.98$; Control: $M = 17.01$, $SE = 1.23$). By 3 months, the TM group had significantly lower fatigue ($M = 12.43$, $SE = 1.05$) compared to the control group ($M = 18.42$, $SE = 1.39$), $p = 0.003$, $d = -0.77$. At 6 months, the TM group further improved ($M = 10.75$, $SE = 1.06$), while the control group worsened ($M = 20.31$, $SE = 1.26$), $p < 0.001$, $d = -1.23$. These results indicate that the TM program contributed to marked improvements in fatigue over time.

3.7 Insomnia severity

The *Group* × *Time* interaction was significant, $F_{(2,295)} = 12.74$, $p < 0.001$, indicating that insomnia symptoms changed differently over time between groups. Neither the main effect of Group [$F_{(1,227)} = 2.64$, $p = 0.105$] nor Time [$F_{(2,295)} = 0.04$, $p = 0.963$] was significant. Age was not a significant covariate, $F_{(1,218)=} 0.22$, $p = 0.639$, and was included as a control variable (see Table 2).

Estimated marginal means and between-group comparisons at each timepoint are presented in Table 3. At baseline, the TM group reported slightly higher insomnia severity ($M = 8.12$, $SE = 0.72$) than the control group ($M = 7.25$, $SE = 0.90$), $p = 0.528$. By 3 months, TM participants had lower scores ($M = 6.36$, $SE = 0.77$) than controls ($M = 9.13$, $SE = 1.02$), though this difference was not statistically significant, $p = 0.067$, $d = -0.48$. At 6 months, the TM group showed significantly lower insomnia severity ($M = 5.57$, $SE = 0.78$) compared to the control group ($M = 10.10$, $SE = 0.93$), $p = 0.002$, $d = -0.79$. This reflects a significant benefit of TM on sleep outcomes by the end of the study period.

4 Discussion

The purpose of this study was to evaluate the effects of Transcendental Meditation (TM) on emotional intelligence (EI), perceived stress, fatigue, and insomnia severity over a 6-month period among Ayurvedic medical students in India. Results from linear mixed-effects models (LMMs) revealed significant *Group* × *Time* interactions for all primary and secondary outcomes, indicating that TM participants and controls followed distinct trajectories over time (see Table 2).

Students in the TM group experienced statistically significant improvements in Global Emotional Intelligence (Global EI) by the 3-month follow-up ($p < 0.001$, $d = 1.18$), with further gains observed at 6 months ($p < 0.001$, $d = 1.67$). These improvements occurred despite similar baseline scores between groups, underscoring the effectiveness of the TM intervention. In contrast, the control group demonstrated minimal or no improvement in EI and, in some cases, a gradual decline. These findings support the hypothesis that regular TM practice enhances emotional development through mechanisms such as improved self-awareness, emotion regulation, and stress resilience. Age was included as a covariate in all models, as students in the control group were significantly older on average, and was a significant predictor of Global EI, $F_{(1,210)} = 5.78$, $p = 0.017$. The *Group* × *Time* interaction remained significant after adjusting for age, indicating that the observed improvements in the TM group were not attributable to demographic differences.

In addition to increases in Global EI, TM participants showed significant reductions in perceived stress ($p = 0.013$, $d = -0.66$ at 3 months; $p < 0.001$, $d = -1.46$ at 6 months), fatigue ($p = 0.003$, $d = -0.77$ at 3 months; $p < 0.001$, $d = -1.23$ at 6 months), and insomnia severity ($p = 0.067$, $d = -0.48$ at 3 months; $p = 0.002$, $d = -0.79$ at 6 months) compared to the control group. These improvements occurred despite comparable baseline scores across all three secondary outcomes. The observed reduction in stress supports the idea that TM may lower physiological reactivity to academic demands. Similarly, the reduction in fatigue reinforces TM's role in promoting psychological recovery, and the improvement in insomnia aligns with research on meditation-based practices and sleep efficiency. These findings are consistent with prior research linking TM to enhanced psychological resilience, reduced stress, and improved sleep (Nidich et al., 2009; Travis et al., 2009; Orme-Johnson and Barnes, 2014).

Secondary analyses revealed that all four Global Emotional Intelligence subdomains (Wellbeing, Emotionality, Self-Control, and Sociability) demonstrated statistically significant *Group* × *Time* interactions (all $p < 0.001$; see Table A1). TM participants exhibited consistent and significant improvements across each subdomain relative to the control group, with moderate to large effect sizes observed at the 3- and 6-month follow-ups (see Table A2). A Bonferroni-adjusted significance threshold of $p < 0.0125$ was applied to the secondary analyses of the Global EI subdomains, and all observed *Group* × *Time* interactions remained robust after correction. These findings indicate that the positive impact of TM on emotional intelligence extended beyond the Global EI composite score to specific facets of emotional functioning.

This study adds to the existing literature by focusing on Ayurvedic medical students in India, a population facing high academic and clinical pressures. Improvements in emotionality and sociability components of EI suggest that TM may enhance interpersonal functioning, which is especially relevant for students preparing for patient-centered clinical roles. The reductions in stress, fatigue, and insomnia also support TM's role in reducing

burnout risk and improving overall wellbeing in demanding educational environments.

A major strength of this study was its longitudinal design, which enabled an assessment of changes in emotional and psychological functioning over time. The use of linear mixed-effects models allowed for the inclusion of all available data, even in the presence of missing values, and provided robust estimates of within- and between-group differences. The implementation of TM within a classroom setting also demonstrated the feasibility of integrating meditation practice into academic curricula.

Notably, the observed improvements in emotional intelligence and secondary outcomes were accompanied by large effect sizes (frequently $d \geq 0.80$) and strong statistical signals, such as $F_{(2,286)} = 32.38$ for the Global EI interaction and $F_{(2,295)} = 12.74$ for insomnia severity. These findings indicate not only statistical significance but also substantial practical relevance, reinforcing the potential value of TM as an intervention for enhancing emotional resilience and psychological wellbeing among medical students.

Several limitations should be considered when interpreting these findings. First, this was an observational, non-randomized study conducted at a single Ayurvedic medical institution in India. As such, the findings may not generalize to students in other academic disciplines or cultural contexts. Participants in the TM group were newly admitted B.A.M.S. students, whereas the control group consisted of older M.D./M.S. (Ayurveda) students. This introduces potential selection bias, as academic level and associated stressors may have differed between groups. Although age was statistically controlled in all analyses, other unmeasured group differences, such as academic workload or life stage, may have influenced the results. Randomized controlled trials are needed to better establish causal effects.

Second, some control group participants had prior exposure to other contemplative practices, such as yoga or mindfulness, which may have influenced psychological outcomes. While this reflects the naturalistic design of the study, future research should consider stratifying participants based on prior contemplative experience to better isolate the specific effects of TM.

Third, TM practice was incorporated into the students' daily academic schedule, and classroom attendance was systematically monitored by the school. Monthly attendance rates for TM sessions ranged from 74.0 to 90.3% across the six-month intervention, with the highest rates observed during the initial months. Although attendance records verified participation in supervised TM sessions during class time, they did not capture adherence to independent twice-daily practice outside of scheduled academic hours, including evenings, weekends, and holidays. Future research should consider implementing systematic and accessible methods for verifying independent practice to further strengthen internal validity.

Fourth, although retention was relatively high at 6 months, interim attrition, particularly in the control group, may have introduced bias and reduced statistical power. Linear mixed-effects modeling helped mitigate the impact of missing data by including all available observations under the assumption that data were missing at random. However, reasons for attrition were not systematically recorded, and if dropout was related to unmeasured factors such as worsening psychological outcomes, some bias may remain. Future studies should consider implementing strategies such as automated reminders, digital follow-up tools, or participant incentives to enhance retention and promote consistency across timepoints.

Additionally, although administrators supervised survey completion, they did not interact with participants regarding their responses. Because participants were assigned to groups based on academic level rather than randomization, they were necessarily aware of whether or not they had received instruction and practice in Transcendental Meditation (TM). This lack of blinding, combined with the non-randomized design, may have introduced some potential for response bias.

Fifth, this study relied exclusively on self-report measures to assess outcomes. Future research should incorporate objective physiological assessments, such as cortisol levels, electroencephalography (EEG), or heart rate variability (HRV), to complement subjective data and provide deeper insights into potential underlying mechanisms of action.

5 Conclusion

This study provides evidence that regular practice of Transcendental Meditation (TM) leads to significant improvements in emotional intelligence (EI), reductions in perceived stress, lower levels of fatigue, and enhanced sleep quality among Ayurvedic medical students in India. Students assigned to the TM group demonstrated significantly greater improvements over time compared to the control group, particularly in emotional intelligence and perceived stress, as indicated by significant *Group* × *Time* interaction effects. These findings suggest that the incorporation of TM into student wellness initiatives may serve as an effective approach to fostering emotional regulation, resilience, vitality, and healthy sleep patterns within high-stress academic environments. However, additional research is needed to assess the generalizability of these outcomes across broader student populations and varied educational settings.

Future investigations should prioritize the use of randomized controlled trial designs to strengthen causal inferences and explore potential moderators that may influence intervention efficacy. Longitudinal studies with extended follow-up periods are also warranted to determine the sustainability of the observed benefits over time. Moreover, research conducted among students from diverse academic disciplines, cultural backgrounds, and institutional contexts will be critical to evaluating the broader applicability of TM as a scalable intervention for promoting student wellbeing on a global scale.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Maharishi International University Institutional Review Board (MIU IRB). The studies were conducted in accordance with the local legislation

and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

CP: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. SN: Supervision, Writing – review & editing, Project administration, Validation. GY: Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Visualization, Writing – review & editing. AW: Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Visualization, Writing – review & editing. SK: Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Visualization, Writing – review & editing. KT: Writing – review & editing, Data curation, Project administration. RW: Supervision, Writing – review & editing. MR: Formal analysis, Methodology, Validation, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

Publisher's note

Supplementary material

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