RESEARCH

Exploring the interplay of academic stress, motivation, emotional intelligence, and mindfulness in higher education: a longitudinal cross-lagged panel model approach

Shan Zhang¹, Shazia Rehman², Yali Zhao^{3*}, Erum Rehman⁴ and Bushra Yagoob⁵

Abstract

Students in higher education often encounter significant academic pressure, which can have profound implications for their mental health and academic performance. The current study employs a two-wave longitudinal design to investigate the dynamic interrelationships among academic stress, academic motivation, emotional intelligence, and mindfulness. The study employed a cross-lagged panel model to investigate the temporal interactions among these four constructs and their influence on the academic experiences of doctoral students. The sample consisted of 643 individuals at Time 1 (September/October 2022), followed by a subsequent assessment involving 413 participants (July/August 2023). Notably, there was an overlap of 373 participants who were evaluated at both time points. The results indicated the presence of substantial reciprocal relationships among the constructs under investigation. The outcomes indicated that elevated emotional intelligence and mindfulness levels are associated with reduced academic stress and enhanced motivation. The implications of this analysis underscore the necessity of facilitating interventions aimed at enhancing emotional intelligence and mindfulness. These components are instrumental in promoting resilience and supporting academic success among students. These longitudinal insights hold significant importance within the academic literature as they elucidate the various stressors doctoral students encounter. Furthermore, this research provides practical implications for educators and policymakers in formulating targeted strategies to enhance student well-being and improve educational outcomes.

Keywords Academic stress, Academic motivation, Emotional intelligence, Mindfulness, Doctoral students, Crosslagged panel model

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Introduction

Academic stress encompasses students' attitudes and behaviors in response to the pressures of fulfilling academic requirements and achieving educational objectives [1]. Students' perceptions of their expectations regarding academic performance contribute to the experience of academic stress [2, 3]. Typically, students experience significant academic pressure due to the expectations imposed by their parents [4], educators [5], and various other factors. It is essential to ascertain the extent to which demographic factors, such as the gender of students and the educational qualifications of their parents, influence academic stress. Deb et al. (2015) [4] posited that parents' educational attainment and occupational status significantly influence their expectations regarding their children's academic performance, contributing to stress in both parents and children. While Huan et al. (2006) [6] refuted any correlation between gender and academic stress, various other studies have indicated a prevalence of higher anxiety and academic stress levels among female students in comparison to their male counterparts [7, 8]. Conversely, Tangade et al. (2011) [9] presented findings that suggest an increased level of academic stress among male students in contrast to female students. Recent research by Wang, Gao, and Wang (2024) [10] highlighted the interplay between engagement, self-efficacy, and anxiety in educational contexts, emphasizing how these factors collectively shape students' learning experiences. Their study, conducted among Chinese university students, provides a nuanced understanding of stress dynamics in academic environments, further underscoring the need for targeted interventions to address anxiety and enhance engagement in high-pressure academic settings. Furthermore, the demands of education contribute significantly to academic stress, particularly among students in their final year of undergraduate studies, who experience elevated stress levels [9]. The existing literature elucidated that students' perceptions of course load and difficulty, test anxiety, final grades, excessive homework assignments, and family financial hardships contribute significantly to the stress experienced by students [11–14]. Khan et al. (2013) [2] articulated that significant academic stress and the delayed identification of academic challenges impede students' capacity to study effectively and manage their time appropriately, resulting in a decline in academic performance.

Empirical research has established a significant association between academic stress and various developmental outcomes, including adjustment [15], mental health [16], and academic achievement [17]. Nevertheless, there has been a paucity of research investigating the relationship between academic stress and academic motivation among doctoral students. Deci et al. (2013) [18] posited a framework for understanding academic motivation, categorizing it into three distinct forms: intrinsic, extrinsic, and amotivation. These three types of motivation can be conceptualized as existing along a motivational continuum determined by the degree of self-determination involved [19, 20]. Intrinsic motivation is the drive that arises from the inherent satisfaction and enjoyment associated with engaging in an academic activity [21]. Extrinsic motivation is characterized by three distinct types: external regulation, introjected regulation, and identified regulation [18]. External regulation pertains to the learning behaviors of students that are influenced by external incentives, such as the prospect of achieving a high salary in the future [22]. When students are governed by introjected regulation, they engage in academic activities primarily to fulfill external expectations placed upon them [22]. Identified regulation refers to motivation influenced by the significance of students' learning behaviors. Amotivation is the absence of intention or perceived value associated with specific behaviors, which may lead to inaction or passive engagement. Previous research has shown a paucity of studies investigating the relationship between stress and academic motivation through the lens of the multidimensional motivation perspective posited by self-determination theory [19, 23]. The findings suggested that students' academic motivation significantly predicts stress levels [19, 23]. Additionally, evidence suggested that intrinsic motivation, regarded as a higher form of self-determined motivation, negatively correlates with academic stress. Conversely, amotivation, considered a lower form of self-determined motivation, positively correlates with academic stress. In the context of extrinsic motivation, the study conducted by Park (2012) [19] revealed a negative correlation between external regulation and stress levels, while identified regulation demonstrated a positive correlation with stress. Furthermore, the study found no correlation between introjected regulation and stress.

Emotion is an internal phenomenon that mobilizes human behavior, prompting individuals to engage with or withdraw from their contextual environment. This response is contingent upon the hedonic tone of the emotions, which can be either positive or negative [24]. Intelligence can be conceptualized as the capacity to adapt effectively to varying contexts [25]. The integration of these concepts yields a definition of emotional intelligence as the capacity of individuals to perceive, comprehend, regulate, and adaptively articulate emotional experiences [26, 27]. Consequently, emotional intelligence can be defined as a construct that elucidates the processes by which emotions are perceived, regulated, and expressed, varying in proficiency across individuals. This understanding is further enhanced by the theoretical framework posited by Petrides's (2011) [28] trait model

of emotional intelligence, which asserts that emotional intelligence is rooted in specific assessable personality traits. A trait model of emotional intelligence has been proposed, positing that emotional intelligence can be conceptualized as an emotional self-efficacy trait. This construct encompasses a constellation of self-perceptions and dispositions related to emotions in the lower tiers of personality hierarchies [29]. Furthermore, empirical evidence has suggested that various subcomponents of emotional intelligence can be enhanced when the design and implementation of intervention programs adhere to established quality standards [30]. For instance, a metaanalytic review underscored the importance of emotional regulation as a critical component of emotional intelligence, which helps mitigate burnout and improve overall satisfaction [31]. Applying these insights to doctoral students highlights the potential of emotional intelligence to buffer academic stress and promote sustained motivation. Emotional intelligence has not consistently been the sole objective of social and emotional learning programs; these initiatives frequently encompass additional related aspects, such as mindfulness, examined explicitly in the present study.

Over the preceding decade, mindfulness has garnered considerable attention across individual [32], academic [33], and organizational spheres [34], underscoring its significance as a foundational competency within professional environments. Mindfulness is a significant determinant in enhancing concentration [35] and mitigating distractions [36]. This, in turn, can facilitate heightened productivity and improve overall performance [37, 38]. Furthermore, research indicated that mindfulness practices can effectively mitigate stress by enhancing mental clarity and tranquility, reducing negative thoughts' prevalence, and fostering creative ideas [39, 40]. Academic institutions and corporations alike increasingly value these attributes as they endeavor to foster optimal performance and enhance the well-being of their students and employees. The prospective association between mindfulness and academic achievement has been extensively examined in various academic settings, yielding insights into the potential advantages of mindfulness practices for enhancing academic outcomes and overall success within the higher educational context. Numerous studies suggested that mindfulness can improve cognitive and emotional functioning, which can, in turn, improve educational proficiency [41]. Research has demonstrated a correlation between mindfulness practices and enhancements in attention and concentration [35], improvements in working memory [42], and a reduction in mind wandering [43]. Cognitive enhancements facilitate effective learning and information processing, improving academic outcomes. In addition, research indicated that mindfulness practices can alleviate stress and improve psychological well-being among university students [44]. Mindfulness may indirectly support academic success by helping students manage exam anxiety, develop self-awareness, and successfully handle academic problems by fostering stress reduction and building self-awareness [33]. Evidence has investigated the significant linkages between mindfulness and academic outcomes in higher education. For instance, a meta-analytic review identified a small-to-moderate positive correlation between mindfulness and academic outcomes. This conclusion was derived from synthesizing results across various studies [45]. Furthermore, a systematic review investigated the relationship between mindfulness and academic outcomes among undergraduate students, providing evidence for a positive correlation between mindfulness practices and academic outcomes, such as improved grades, examination efficiency, and overall academic accomplishment [41].

Self-determination theory (SDT) provides a robust framework for understanding motivation in academic contexts, emphasizing the role of autonomy, competence, and relatedness in driving intrinsic and extrinsic motivation [21, 46]. Recent work by Wang and Wang (2024) explored SDT in the context of Chinese EFL learners' engagement with large language models, offering valuable insights into how self-determined motivation enhances learning engagement and reduces stress [47]. This perspective aligns closely with the current study, highlighting the critical role of SDT in understanding doctoral students' motivation amidst academic challenges.

The present study

Although existing literature has examined the effect of psychological variables independently on academic performance, a dearth of longitudinal studies continues to analyze the dynamic interplay of these variables concerning doctoral education within the Pakistani educational system. Therefore, this research study aims to investigate the longitudinal relationship between stress in academia and critical psychological resources, a relationship that appears virtually empirically unexplored in the available literature. This investigation has gone a step further in understanding the complex interrelations among academic stress, academic motivation, emotional intelligence, and mindfulness among Pakistani doctoral candidates. In this line, the primary purpose of the current study was to examine longitudinal relationships and causal paths among the identified variables using a crosslagged panel model. This approach captures both the within- and between-person-level dynamics that affect the academic experiences of doctoral students.

The motivation for this study arises from the necessity to explore the distinctive stressors doctoral candidates encounter in Pakistan. Educational challenges and cultural expectations may significantly intensify academic pressures in this context. The present study seeks to elucidate the factors that impact academic stress and motivation among doctoral students. By delineating these influences, the research aims to provide evidence-based insights that can guide the development of interventions designed to assist doctoral students in effectively managing stress and sustaining motivation throughout their academic endeavors. The unique contributions of the study are presented in Fig. 1. Consequently, this study proposed the following research questions:

Research Question 1 (RQ-1) *How do academic motivation, emotional intelligence, and mindfulness independently predict academic stress among doctoral students in Pakistan?*

Research Question 2 (RQ-2) What are the longitudinal effects of academic motivation on academic stress in the context of doctoral education?

Research Question 3 (RQ-3) How does emotional intelligence contribute to reducing or escalating academic stress over time in doctoral students?

Research Question 4 (RQ-4) What is the role of mindfulness in influencing academic stress across different time points in a longitudinal framework?

Research Question 5 (RQ-5) Do the predictive strengths of academic motivation, emotional intelligence, and mind-fulness differ in their impact on academic stress in Pakistani doctoral candidates?

Methods

Research design and participants

The study population consisted of doctoral candidates in public universities in Islamabad, Pakistan. The selection of study participants from public universities within this category was predicated on the necessity to incorporate diversity into the sample. This approach facilitates a comprehensive examination of the various experiences that students may encounter with diversifying academic fields of study. This criterion indicates that the composition of this category of study participants will encompass individuals from a diverse range of fields, including the sciences, humanities, social sciences, and engineering. Furthermore, the criteria established for data collection mandated that participants remain available for additional data collection activities one year after the initial survey. The exclusion criteria for this study encompassed students who were not enrolled full-time in their doctoral programs, individuals who transferred from another institution during the study, and participants who were concurrently engaged in other structured stress reduction programs external to this research. A two-wave longitudinal design was employed, comprising data collection at two distinct time points with a one-year interval between them. The baseline data were gathered from September-October 2022 (T1), followed by a follow-up assessment one year later, from July-August 2023 (T2). The longitudinal methodology facilitated an investigation into the temporal alterations and causal connections among academic stress, academic motivation, emotional intelligence, and mindfulness. This research design was selected to investigate the interrelationships among these constructs within a high-pressure academic setting and examine their progression throughout the academic year. Participants were recruited via university email distribution lists and social media platforms for



academic networking. Informed consent was acquired from all participants before engaging in the study. At baseline time, participants participated in the completion of a self-reported online questionnaire that encompassed assessments of academic stress, academic motivation, emotional intelligence, and mindfulness. The follow-up data collection for Time 2 was conducted one year later, utilizing the same questionnaire to evaluate alterations in the specified constructs.

At the baseline period (T1), a total of 643 doctoral candidates participated, and in the course of the follow-up data collection conducted at T2, a total of 413 students completed the survey, with an overlap of 373 participants who participated at both times of survey, thereby providing a consistent sample for longitudinal analysis. Of these participants, 54.5% were females, and 45.5% were males, with an average age of 29.56 (Table 1).

Measures

- Academic stress: To assess academic stress and its associated stressors, this study utilized the scale developed by Lin et al. (2009) [48]. This scale encompasses seven specific academic stressors: Teachers' Stress, Results Stress, Test Stress, Stress of Studying in a Group, Peer Stress, Time Management Stress, and Self-inflicted Stress (Fig. 2). The instrument consisted of 34 items on a fivepoint Likert scale, with responses ranging from 5 (completely agree) to 1 (completely disagree). The Cronbach's alpha coefficients for the components of each questionnaire for the original scale ranged from 0.85 to 0.92, with the alpha value for the academic stress questionnaire specifically reported at 0.90 [48].
- Academic motivation: Academic motivation was assessed using the Academic Motivation Scale (AMS) developed by Vallerand et al. (1993) [46] based on self-determination theory, which differentiates between types of motivation based on their level of autonomy and self-determination. The Academic Motivation Scale (AMS) is a selfadministered 28-item measure designed to measure students' intrinsic and extrinsic motivations for academic activities and their level of amotivation (Fig. 2). It provides insights into how different types of motivation influence students' academic engagement and performance. Items are grouped

| Table I Demographics distribution of the participant | Table 1 | Demograp | hics distri | ibution c | of the | particip | oant: |
|--|---------|----------|-------------|-----------|--------|----------|-------|
|--|---------|----------|-------------|-----------|--------|----------|-------|

| | T1 (643) | T2 (413) | Overlap (373) |
|------------|----------|----------|---------------|
| Gender | | | |
| Male | 45.67% | 47.34% | 46.70% |
| Female | 54.33% | 52.66% | 53.30% |
| Age (mean) | 30.09 | 28.98 | 29.18 |

according to the dimensions they measure. Scores for each dimension are computed by averaging the responses to the items within that dimension. Each item is rated on a 7-point Likert scale, ranging from "Not at all true" (1) to "Very true" (7). the AMS has demonstrated good internal consistency, with Cronbach's alpha coefficients typically ranging from 0.70 to 0.90 for the different subscales. The scale has shown strong construct validity, with significant relationships between AMS subscales and educational outcomes like academic performance, engagement, and satisfaction.

- *Emotional intelligence*: A self-reported emotional intelligence scale (EIS) developed by Schutte et al. (1998) [49] was adopted to assess the participants' emotional intelligence. The EIS comprised 33 items, with three reversed scores (Fig. 2). Participants were required to rate the extent they agree or disagree with each item on a 5-point Likert response scale (1: strongly disagree to 5: strongly agree). The final score is obtained by summing up the responses to the items, with a high value indicating higher emotional intelligence. Several empirical investigations have demonstrated good validity and reliability among healthcare professionals [50–54].
- Mindfulness: This study utilized the Five Facet Mindfulness Questionnaire - Short Form (FFMQ-SF) to measure mindfulness. The FFMQ-SF is a 24-item questionnaire that comprehensively assesses mindfulness by measuring five distinct facets: Observing, Describing, Acting with Awareness, Non-Judging, and Non-Reacting (Fig. 2). These facets collectively capture the multidimensional nature of mindfulness as a construct [55]. The short form was developed by Bohlmeijer et al. (2011) [56] and has been validated for use in various populations, demonstrating good psychometric properties [57– 60]. Responses to the FFMQ-SF are collected using a 5-point Likert scale, ranging from 1 ("Never or Very Rarely True") to 5 ("Very Frequently or Always True"). Participants were instructed to respond to each item based on their typical experiences over the last month. To obtain the final average score for each facet, the scores for the individual items within each facet were summed and then divided by the number of items in that facet. The facet scores can be interpreted independently or combined to obtain an overall mindfulness score. Higher scores on the FFMQ-SF indicated higher levels of mindfulness.

Pilot testing

All scales employed in this study were reviewed and slightly modified to reflect the unique challenges faced by postgraduate students in Pakistan. For instance, items on





Fig. 2 Components of academic stress, motivation, emotional intelligence, and mindfulness

the Academic Stress Inventory were adapted to capture research-specific stressors, supervisory relationships, and dissertation-related pressures. Similarly, the AMS was refined to address motivations associated with professional and research goals. The EIS and the FFMQ-SF were also adjusted to ensure cultural and contextual relevance while retaining their theoretical integrity. Experts in education and psychology reviewed these modifications to ensure content validity and appropriateness. To validate the modified scales, a pilot study was conducted with a subset of postgraduate students (n=45) prior to the main study. The pilot study assessed reliability, yielding Cronbach's alpha coefficients ranging from 0.78 to 0.91 across all scales, indicating strong internal consistency. Feedback collected from participants confirmed the clarity and relevance of the modified items.

Statistical analysis

To investigate the study objectives within the framework of a CLPM analysis, path models were analyzed utilizing the R programming environment [61] and the procedure of Hakanen et al. (2008) [62] (Fig. 3), which was followed by Konze et al. (2017) [63]. To enhance our comprehension of the underlying causal mechanisms and following the work of Konze et al. (2017) [63], multiple competing full-panel path models were incorporated to investigate the cross-lagged (CL) relationships while controlling for variables such as age and gender.

Model 1

The stability model exclusively incorporated autoregressive effects to account for the baseline levels of each variable. Incorporating autoregressive effects into the path models facilitates (a) an evaluation of the temporal



Fig. 3 Path models for investigating CLPM analysis

stability and, more significantly, (b) predicting changes in academic stress over time.

Model 2

The proposed causal relationships were incorporated alongside the autoregressive effects in the causality model.

Model 3

In the reversed causation model, autoregressive effects with inverse effects were integrated to assess whether the causal relationships operate in a manner contrary to the initially hypothesized effects.

Model 4

The reciprocal model, Model 2, and Model 3 were integrated to examine the bidirectional influence between the constructs over time.

Furthermore, model fit indices were evaluated to compare the efficiency of the four models using the Comparative Fit Index (CFI \geq 0.95), Root Mean Square Error of Approximation (RMSEA \geq 0.05), and Chi-square difference test.

Results

Panel attrition

In order to investigate whether systematic attrition of participants between the initial and second data collection periods may have influenced the results, a comparative analysis was conducted between the panel group (n=373, overlapped participants)— and the dropouts (present at baseline period T1). This was accomplished by estimating Students' t-tests employing baseline data (T1). No statistically significant differences were observed between the two groups for demographic and study variables. Consequently, it can be inferred that any systematic dropout did not significantly affect the study results.

| Table 2 | Standardized factor loadings for the measurement |
|---------|--|
| model | |

| Parameter estimate | Standard- ized factor loadings | | |
|--|--------------------------------------|---------|--|
| | At T1 | At T2 | |
| Academic stress → Teachers' Stress | 0.89*** | 0.91*** | |
| Academic stress → Results Stress | 0.91*** | 0.90*** | |
| Academic stress \rightarrow Test Stress | 0.87*** | 0.90*** | |
| Academic stress \rightarrow Stress of Studying in a Group | 0.89*** | 0.91*** | |
| Academic stress \rightarrow Peer Stress | 0.85*** | 0.89*** | |
| Academic stress \rightarrow Time Management Stress | 0.79*** | 0.80*** | |
| Academic stress \rightarrow Self-inflicted Stress | 0.88*** | 0.89*** | |
| Academic motivation \rightarrow Intrinsic motivation | 0.78*** | 0.81*** | |
| Academic motivation \rightarrow Extrinsic motivation | 0.77*** | 0.80*** | |
| Academic motivation \rightarrow Amotivation | 0.87*** | 0.86*** | |
| Emotional intelligence \rightarrow Perception of emotion | 0.89*** | 0.88*** | |
| Emotional intelligence \rightarrow Managing own emotions | 0.90*** | 0.89*** | |
| Emotional intelligence \rightarrow Managing others' emotions | 0.85*** | 0.88*** | |
| Emotional intelligence \rightarrow Utilization of emotion | 0.86*** | 0.89*** | |
| $Mindfulness \rightarrow Observing$ | 0.85*** | 0.87*** | |
| $Mindfulness \rightarrow Describing$ | 0.78*** | 0.82*** | |
| Mindfulness \rightarrow Acting with Awareness | 0.91*** | 0.88*** | |
| Mindfulness \rightarrow Non-Judging | 0.88*** | 0.89*** | |
| Mindfulness → Non-Reacting | 0.87*** | 0.88*** | |
| Nata ***= +0.001 | | | |

Note ***p<0.001

Measurement model

In the subsequent phase of our analysis, the overall measurement model utilizing confirmatory factor analysis (CFA) was evaluated. Following the requirement for measurement invariance, factor loadings, and intercepts were constrained to be equal across different time points. Furthermore, the residual errors associated with the same items were permitted to exhibit correlations over time. Due to the large number of items used to measure each latent construct, the items for all constructs into parcels were aggregated (Table 2). This procedure presents several advantages, including a reduction in parameter bias, enhanced reliability, improved normality in data distribution, increased simplicity of the model, effective management of multicollinearity, and an overall enhancement in model fit [64]. The domain-representative parceling method was employed for all four multidimensional constructs by amalgamating items from each subscale to formulate distinct parcels for each construct [65]. The CFA model that allowed all factors to be correlated over time demonstrated a good fit for the data ($\chi^2 = 76.53$, p < 0.01; CFI=0.973; TLI=0.943; RMSEA=0.05).

Structural model test analysis

Based on the CLPM analysis results presented in Table 3, four different models are assessed and compared: stability, causality, reversed causation, and reciprocal. The stability model (M1) examines the consistency of variables

Table 3 Measurement invariance

Note M1: stability model, M2: causality model, M3: reversed causation model, M4: reciprocal model. As the chi-square statistic for assessing model fit is sensitive to sample size, the CFIs and RMSEAs of the models using a cut-off value of 0.01 were compared [66]

across time points, showing good fit indices with χ^2 =36.51, RMSEA of 0.043, and CFI of 0.964. These values indicate a strong fit, suggesting the constructs are relatively stable across both time points. The causality model (M2) assesses whether predictors at T1 influence outcomes at T2, with a $\chi^2 = 16.09$, RMSEA of 0.043, and CFI of 0.963. The minimal changes in CFI (-0.001) and RMSEA (0.000) compared to the stability model suggest that the directional paths from T1 to T2 fit well within the data structure. The reversed causation model (M3) tests whether outcomes at T1 influence predictors at T2, with $\chi^2 = 21.35$, RMSEA of 0.042, and CFI of 0.963. This model fits similarly to the causality model, suggesting that reverse causation paths are plausible, with a slightly better RMSEA indicating a good fit. The reciprocal model (M4) evaluates bidirectional influences between variables over time, demonstrating excellent fit with χ^2 =5.78, RMSEA of 0.043, and CFI of 0.964. This suggests that bidirectional relationships between variables likely support complex interdependencies over time. All models have acceptable fit indices, with CFI values above 0.95 and RMSEA values below 0.05, indicating a good fit across models. The slight variations in ΔCFI and $\Delta RMSEA$ suggest that each model provides unique insights into the relationships between the constructs, with the reciprocal model showing the most robust fit. The results suggest the potential for stability, causality, reverse causation, and reciprocal influences, highlighting the complexity of relationships among academic stress, motivation, emotional intelligence, and mindfulness over time. The overall outcomes of the CLPM analysis exhibit that while all models fit well, the reciprocal model provides the most comprehensive understanding of the bidirectional relationships between the study constructs (Fig. 4).

Descriptive, reliability, validity analysis

Table 4 presents the descriptive estimates and reliability and validity analysis findings, including the assessment of Cronbach's alpha, composite reliability, and average variance extracted (AVE) for each study construct, evaluated at two distinct time points. The reliability metrics, specifically Cronbach's alpha, exceed the threshold of 0.80 for all constructs measured, demonstrating high internal consistency across both time points. The composite reliability values are also elevated, indicating that the constructs are measured with a high degree of reliability. The AVE values \geq 0.50, indicating strong convergent validity. This finding suggests that each construct accounts for a significant proportion of the variance associated with its respective items.

Bivariate correlation analysis

Table 5 presents the bivariate correlational analysis of the study variables at two different time points (T1 and T2). At T1, there are significant negative correlations between academic stress and both academic motivation (r= -0.43, p<0.001) and emotional intelligence (r = -0.37, p<0.001), indicating that higher stress levels are associated with lower motivation and emotional intelligence. Similarly, mindfulness shows a negative correlation with academic stress (r = -0.32, p<0.001) and positive correlations with academic motivation (r=0.52, p<0.001) and emotional intelligence intelligence (r= -0.55, p<0.001), suggesting that higher mindfulness is related to lower stress and higher motivation and emotional intelligence.

Likewise, at T2, academic stress continues to have significant negative correlations with academic motivation (r = -0.36, p < 0.001), emotional intelligence (r = -0.33, p < 0.001), and mindfulness (r = -0.27, p < 0.01). Academic motivation at T2 positively correlates with emotional intelligence (r=0.42, p < 0.001) and mindfulness (r=0.46, p < 0.001), indicating that higher motivation is associated with higher emotional intelligence and mindfulness. Emotional intelligence at T2 correlates positively with mindfulness (r=0.53, p < 0.001), showing consistent relationships across both time points. Overall, the data demonstrate stable patterns of relationships over time, with significant associations supporting the study's theoretical framework.

Discussion

This study employed a longitudinal design to explore the across-time interplay of academic stress, academic motivation, emotional intelligence, and mindfulness among doctoral students in Pakistan. This research was unique in its focus on a demographic facing distinct educational stresses and challenges, offering valuable insights into the interactions of psychological variables in high-stakes academic environments. The findings indicated significant



Fig. 4 Cross-lagged path analysis among study variables at two timeframes (T1: baseline period, T2: one-year interval).**p < 0.01. ***p < 0.001

| | $Mean \pm SD$ | Cron- bach's alpha | Com- posite reliability | Average variance extracted |
|--------------------------------|-----------------|--------------------------|-------------------------------|----------------------------------|
| Academic stress (T1) | 4.5±0.813 | 0.89 | 0.924 | 0.689 |
| Academic motivation (T1) | 4.91±0.891 | 0.91 | 0.851 | 0.617 |
| Emotional intelligence (T1) | 3.5±0.693 | 0.87 | 0.943 | 0.692 |
| Mindfulness (T1) | 3.9 ± 0.667 | 0.88 | 0.829 | 0.589 |
| Academic stress (T2) | 4.7 ± 0.765 | 0.90 | 0.911 | 0.654 |
| Academic motivation (T2) | 5.01±0.992 | 0.91 | 0.872 | 0.598 |
| Emotional intelligence (T2) | 3.7±0.710 | 0.88 | 0.939 | 0.668 |
| Mindfulness (T2) | 3.8±0.612 | 0.87 | 0.845 | 0.612 |

Table 4 Reliability and validity analysis

mediating effects, suggesting that higher levels of emotional intelligence and mindfulness were associated with reduced academic stress, which, over time, contributed to increased motivation. These results emphasized the importance of interventions to develop emotional intelligence and mindfulness, highlighting their potential to enhance doctoral students' ability to manage academic stress and maintain motivation throughout their academic journeys. Such interventions hold significant promise for promoting educational success and well-being, equipping doctoral students with the skills needed to navigate the complexities of their academic and professional demands effectively.

The findings indicated a negative correlation between academic stress and motivation at both measured time points (T1-T2). This result aligned with prior research suggesting that elevated stress levels were associated with a decrease in students' motivation and engagement in academic activities [22, 67-69]. This phenomenon was particularly significant within the context of higher education in Pakistan, where doctoral students frequently encountered substantial academic pressure and elevated expectations [70, 71]. Halai et al. (2011) [72] emphasized that students conceptualized and engaged the doctoral program primarily as a professional degree rather than a research orientation qualification. Addressing stress within the educational context was imperative for creating a more conducive learning environment that promotes student motivation and enhances academic success.

In addition, emotional intelligence was observed as one of the potent predictors of academic stress and motivation. Our results also demonstrated at baseline a significant positive correlation between greater emotional intelligence, decreased academic stress, and increased academic motivation. This suggested that students with

| | AS at T1 | AS at T1 AM at T1 | AM at T1 El at T1 M at T1 | M at T1 | AS at | AM at T2 | El at T2 | M at T2 |
|--|--|--|---|---|---------------------------------------|-------------------------|--------------|------------|
| | | | | | T2 | | | |
| AST1 | 1 | | | | | | | |
| AM at T1 | -0.43*** | 1 | | | | | | |
| El at T1 | -0.37*** | 0.47*** | 1 | | | | | |
| M at T1 | -0.32*** | 0.52*** | 0.55*** | 1 | | | | |
| AS at T2 | 0.60*** | -0.36*** | -0.33*** | -0.27** | 1 | | | |
| AM at T2 | -0.36*** | 0.69*** | 0.42*** | 0.46*** | -0.52*** | 1 | | |
| El at T2 | -0.33*** | 0.43*** | 0.67*** | 0.53*** | -0.43*** | 0.53*** | 1 | |
| M at T2 | -0.27** | 0.46*** | 0.53*** | 0.70*** | -0.37*** | 0.58*** | 0.61*** | 1 |
| AM at T1 El at T1 M at T1 AS at T2 AM at T2 El at T2 M at T2 | -0.43*** -0.37*** -0.32*** 0.60*** -0.36*** -0.33*** -0.27** | 1 0.47*** 0.52*** -0.36*** 0.69*** 0.43*** 0.46*** | 1 0.55*** -0.33*** 0.42*** 0.67*** 0.53*** | 1 -0.27** 0.46*** 0.53*** 0.70*** | 1 -0.52*** -0.43*** -0.37*** | 1 0.53*** 0.58*** | 1 0.61*** | 1 |

Table 5 Bivariate correlational analysis of study variables at two different periods (n = 322)

Note AS: academic stress, AM: academic motivation, EI: emotional intelligence, M: mindfulness. T1: baseline period. T2: one-year interval. ***p<0.001. **p<0.01

developed emotional regulation and understanding were better equipped to cope with academic stressors [73–75]. In the setting of Pakistan, where cultural norms reinforce emotional suppression, the inculcation of emotional intelligence skills could enable students to cope with loads of academic and personal hassles [76-78]. Importantly, positive interrelationships among mindfulness, academic motivation, and emotional intelligence demonstrated that mindfulness can be highly valued for educational practice. Mindfulness practices further increase the capacity of students to be present and attentive, have buffering effects against stress, and build emotional and motivational resources [79, 80]. These interconnections bear essential and practical significance for doctoral students in Pakistan, who often find themselves facing various responsibilities that encompass both teaching and research activities [81-83].

The reciprocal model furnished a thorough comprehension of the bidirectional relationships existing among the variables. The findings of this model indicated a reciprocal relationship between academic stress and motivation over time, suggesting the presence of a feedback loop in which elevated stress levels may lead to a reduction in motivation while decreased motivation may, conversely, exacerbate stress levels. Similarly, emotional intelligence and mindfulness exhibited reciprocal influences, thereby underscoring that these constructs mutually impact stress and motivation while being shaped by these factors [84, 85]. These bidirectional associations indicated that enhancing emotional intelligence and mindfulness may foster a reciprocal positive cycle, reducing stress and increasing motivation. In light of the competitive academic landscape in Pakistan, promoting these skills may significantly enhance student resilience and improve academic achievement. The stability model showed that the constructs have significant stability over different points in time. However, the CLPM analyses also suggested possible causal pathways among the constructs. The findings indicated that emotional intelligence and mindfulness intervention can significantly alleviate academic stress and enhance motivation over time, suggesting the complicity of these relationships [86, 87].

Implications for practice

Educators and practitioners must consider integrating emotional intelligence and mindfulness training into the foundational framework of educational practices. It has to be adopted to have highly positive changes in the student's academic performance, which has a cascading effect on personal development. The above-outlined interventions have been influential in reducing the negative impacts of academic pressures and motivating students to engage in the educational process [30, 88]. Pakistani universities have a distinctive opportunity to address cultural and educational challenges by employing various strategies and initiatives. Customized intervention programs can potentially equip students with effective stress management techniques, enhancing their academic performance. Consequently, educators must incorporate specialized lessons to foster an awareness of mindfulness within their existing classroom practices and activities. Additionally, they should provide relevant workshops or mentorship opportunities that facilitate the practical application of this conceptual understanding. Furthermore, establishing resource centers or implementing digital platforms would facilitate enhanced accessibility for learners to educational materials and support services. Such integrated approaches equip students with the necessary skills and resources to navigate the complexities of academic life and succeed in academic processes.

Limitations and future research

A few limitations should be acknowledged when making inferences from the results. First, self-report measures will introduce response biases because students may tend to under-report or over-report certain behaviors and emotional states. This occurs due to social desirability and the inaccuracy of self-assessment. While the sample was sizable, this was restricted only to doctoral students from Pakistan, so there may be implications for generalizability to other educational contexts. Although the duration taken in the study is long enough to make the observations for any short-term changes, in order to understand the long-term effects and the interaction between the variables, this study may fall short. Therefore, future research should assess such associations in populations that vary widely and over extended periods. An analysis of potential mediators and moderators, such as personality traits and socioeconomic status, is also expected to offer more detailed insight into the mechanisms underlying these associations. Finally, while the scales were modified and tested for reliability to suit postgraduate students in Pakistan, their original designs were not specific to this population. Future research could benefit from developing and validating scales tailored to the unique academic and cultural contexts of postgraduate students in South Asia.

Conclusion

The findings of this research contributed to a deeper understanding of the interplay between emotional intelligence and mindfulness and their effects on academic stress and motivation among doctoral candidates in Pakistan. This understanding will equip supervisors to offer more effective support to students, thereby promoting their well-being and academic progress. These reciprocal associations underscored the significance of developing motivational and emotional interventions. This necessitates establishing a conducive learning environment that fosters resilience and facilitates academic achievement.

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Author contributions

SZ: Formal analysis, Methodology, Visualization, Validation, Writing – original draft, Writing – review & editing. SR: Conceptualization, Formal analysis, Methodology, Visualization, Writing – original draft, Writing – review & editing. YZ: Formal analysis, Methodology, Visualization, Validation, Writing – original draft, Writing – review & editing. ER: Conceptualization, Pormal analysis, Methodology, Visualization, Writing – original draft, Writing – review & editing. FR: Conceptualization, Formal analysis, Methodology, Visualization, Writing – original draft, Writing – review & editing, Funding. BY: Conceptualization, Data curation, Formal analysis, Methodology, Visualization, Writing – original draft, Writing – review & editing. All authors read and approved the final version of the manuscript for publication.

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Data availability

The raw data that support the findings of this study are available upon reasonable request from the author (Bushra Yaqoob, researcherhead90@gmail. com).

Declarations

Informed consent

Informed consent was obtained from all subjects involved in the study.

Consent to publish

Not applicable.

Institutional review board statement

The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Ethics Review Committee of the Women University, Multan (ref#WU-01681/23).

Competing interests

The authors declare no competing interests.

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