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A structural model of cognitive correlates of academic burnout among medical students: a cross-sectional study

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Abstract

Background

Academic burnout is a substantial concern in medical education and may be associated with maladaptive and protective cognitive processes. This study examined a structural model linking cognitive avoidance, cognitive distortions, cognitive fusion, and mindfulness with academic burnout among medical students and tested whether the structural relationships differed across handedness-based laterality groups.

Methods

This cross-sectional correlational study included 333 general medical students at Shiraz University of Medical Sciences, Iran. Academic burnout, cognitive avoidance, cognitive distortions, cognitive fusion, and mindfulness were assessed using standardized self-report measures, and hand preference was assessed with the Edinburgh Handedness Inventory. Structural equation modeling with maximum likelihood estimation was used to test the model. The indirect association of mindfulness with academic burnout through cognitive fusion was assessed using the Sobel test, and multigroup analysis compared two laterality groups.

Results

Although the model chi-square was significant ($\chi^2(153) = 310.352$, $p < .001$), other fit indices indicated acceptable fit (GFI = .946, AGFI = .925, CFI = .974, RMSEA = .043). Cognitive distortions ($\beta = .179$), cognitive fusion ($\beta = .159$), and cognitive avoidance ($\beta = .133$) were positively associated with academic burnout, whereas mindfulness was negatively associated with burnout ($\beta = -.125$) and cognitive fusion ($\beta = -.170$). The indirect association of mindfulness with burnout through cognitive fusion was significant ($\beta = -.027$, $p < .001$). The model explained 10.2% of burnout variance. Structural paths did not differ significantly across laterality groups ($\Delta\chi^2(20) = .856$, $p > .999$).

Conclusions

Cognitive distortions, cognitive fusion, and cognitive avoidance were associated with higher academic burnout, whereas mindfulness was associated with lower burnout. Cognitive fusion may represent one statistical pathway linking mindfulness with burnout. These findings identify potentially relevant cognitive correlates for future preventive and intervention research, but the cross-sectional design precludes causal inference.

Background

Academic burnout has emerged as an important psychological concern in higher education and reflects an adverse academic state that may have substantial consequences for students' functioning. It is commonly characterized by exhaustion resulting from academic demands, disengagement or cynicism toward academic tasks, and a reduced sense of academic efficacy [1]. Prolonged burnout has been associated with poorer academic performance, reduced motivation, absenteeism, and intentions to discontinue education [2–4]. Recent evidence suggests that academic burnout is relatively common among university students, highlighting the importance of identifying psychological factors that may either increase vulnerability to burnout or protect students against it [3, 4].

Medical students may be particularly vulnerable to academic burnout because of intensive workloads, continuous evaluation, academic competition, and prolonged exposure to demanding educational environments. From a cognitive perspective, burnout may be associated not only with external academic demands but also with the ways in which students interpret, process, and respond to stressful academic experiences. Cognitive avoidance, cognitive distortions, and cognitive fusion represent potentially maladaptive cognitive processes that may increase vulnerability to burnout, whereas mindfulness may function as a potentially protective psychological resource.

Cognitive avoidance refers to a set of strategies used to divert attention from distressing thoughts or threatening experiences. These strategies may include thought suppression, thought substitution, distraction, avoidance of threatening situations, and transforming mental imagery into verbal thought [5]. Although such strategies may temporarily reduce distress, their persistent use may interfere with adaptive coping and contribute to dysfunctional responses to academic stress. Previous studies have reported associations between cognitive avoidance and burnout-related outcomes, suggesting that students who rely more heavily on avoidant cognitive strategies may be more susceptible to academic exhaustion and disengagement [6, 7].

Another potentially important risk factor is cognitive distortion, which refers to biased or inaccurate patterns of information processing through which individuals interpret events in disproportionately negative or dysfunctional ways. Such distortions may interfere with realistic appraisal of academic experiences and effective emotional regulation under stressful conditions. Previous research has linked cognitive distortions with burnout in university students, graduate students, teachers, and healthcare professionals [8–12]. These findings suggest that distorted interpretations of academic challenges—for example, catastrophizing, overgeneralization, negative prediction, or discounting positive experiences—may contribute to the development or maintenance of academic burnout. In demanding academic environments such as medical education, repeated negative interpretations of performance and future academic outcomes may therefore represent an important cognitive vulnerability.

Cognitive fusion constitutes a further maladaptive process that may be relevant to academic burnout. Cognitive fusion describes a state in which individuals become excessively entangled with the literal content of their thoughts and have difficulty distinguishing thoughts from direct reality [13–15]. When cognitive fusion is high, negative thoughts such as anticipated failure, inadequacy, or inability to cope

may exert disproportionate influence over emotions and behavior. In contrast, cognitive defusion or cognitive distancing allows individuals to experience thoughts as transient psychological events rather than objective representations of reality. Previous studies have reported associations among cognitive fusion, cognitive distortions, emotional difficulties, and burnout-related outcomes [10, 12, 13], supporting the inclusion of cognitive fusion as a potential cognitive risk factor in models of academic burnout.

In contrast to these maladaptive cognitive processes, mindfulness may represent a protective factor against academic burnout. Mindfulness is generally characterized by purposeful awareness of present-moment experiences accompanied by a nonjudgmental and receptive orientation. It encompasses attention to current experiences, awareness, openness, and reduced automatic judgment of thoughts and emotions [16, 17]. Evidence from previous research indicates that higher mindfulness is associated with lower levels of academic burnout, while mindfulness-based interventions may reduce burnout among medical students [18–20]. The potential relevance of mindfulness may be particularly important in medical education, where students are repeatedly exposed to academic evaluation, uncertainty, high workloads, and emotionally demanding learning experiences.

Mindfulness may also be associated with academic burnout indirectly through its relationship with cognitive fusion. A mindful orientation allows individuals to observe thoughts and emotions without necessarily identifying with or reacting automatically to them. Accordingly, greater mindfulness may be associated with lower cognitive fusion and greater psychological distance from negative academic thoughts. Empirical studies have demonstrated significant relationships between mindfulness and cognitive fusion, and recent research has emphasized cognitive fusion as a potentially important mechanism linking mindfulness with psychological functioning [21–24]. Thus, cognitive fusion may represent one pathway through which mindfulness is associated with lower academic burnout.

Taken together, previous findings suggest that academic burnout may be better understood through an integrated framework incorporating both cognitive risk factors and a protective cognitive factor. Cognitive avoidance, cognitive distortions, and cognitive fusion may represent maladaptive processes associated with greater burnout, whereas mindfulness may be associated with lower burnout both directly and indirectly through reduced cognitive fusion. However, these variables have typically been investigated separately, and their simultaneous structural relationships with academic burnout remain less clearly understood, particularly among medical students.

The present study therefore aimed to examine a structural model of cognitive factors associated with academic burnout among medical students at Shiraz University of Medical Sciences. Specifically, the model examined the associations of cognitive avoidance, cognitive distortions, cognitive fusion, and mindfulness with academic burnout, as well as the indirect association between mindfulness and academic burnout through cognitive fusion. In addition, the study examined whether the structural relationships varied across handedness-based laterality groups. The primary objective was to provide an integrated account of cognitive risk and protective factors associated with academic burnout in medical students.

Methods

Participants and procedure

This cross-sectional correlational study was conducted at Shiraz University of Medical Sciences, Shiraz, Iran. The study population comprised 2,596 students enrolled in the general medicine program. Based on the Krejcie and Morgan sample-size table [25], a target sample of 335 students was determined. After incomplete questionnaires were excluded, 333 responses were available for analysis.

Eligibility criteria were current enrollment as a general medical student at Shiraz University of Medical Sciences and willingness to participate. Students who declined participation or returned incomplete questionnaires were excluded.

Data were collected using standardized self-report instruments assessing academic burnout, cognitive avoidance, cognitive distortions, cognitive fusion, and mindfulness. Hand preference and laterality were assessed using the Edinburgh Handedness Inventory [26, 27]. All measures were completed as part of the same study assessment.

For the laterality analysis, a Laterality Quotient (LQ) was calculated from participants' right- and left-hand preferences on the Edinburgh Handedness Inventory. Participants were classified into handedness-based laterality categories according to the study's LQ classification procedure informed by Dragovic [28]. The bilateral/mixed category was excluded from the subsequent multigroup comparison of the two lateralized groups.

The study protocol was reviewed and approved by the Research Ethics Committees of Shiraz University of Medical Sciences (approval code IR.SUMS.REC.1400.284; approval date 13 June 2021). The study was conducted in accordance with the ethical principles and national standards governing medical research in Iran. Informed consent was obtained from all participants before participation. Participation was voluntary, and participants could decline or discontinue participation without penalty.

Measures

Edinburgh Handedness Inventory: Hand preference and laterality were assessed using the 10-item Edinburgh Handedness Inventory, originally developed by Oldfield [26]. The instrument assesses preferences for performing common activities with the right or left hand and was used in the present study to calculate a Laterality Quotient for each participant. Previous research reported reliability coefficients ranging from 0.87 to 0.98 for this instrument [27].

The Laterality Quotient derived from the inventory was subsequently used to classify participants into laterality groups. These classifications served as the grouping variable in the multigroup structural analysis examining whether the relationships among the cognitive variables and academic burnout differed according to laterality.

Cognitive Fusion Questionnaire: Cognitive fusion was assessed using the Cognitive Fusion Questionnaire developed by Gillanders et al. [13]. The questionnaire consists of seven items rated on a 7-point Likert scale ranging from 1 (never) to 7 (always), with higher scores indicating greater cognitive fusion. The original validation research reported Cronbach's alpha coefficients of 0.75 and 0.81. In the present study, the questionnaire demonstrated acceptable internal consistency, with a Cronbach's alpha coefficient of 0.79.

Cognitive fusion was included in the structural model both as a cognitive risk factor associated with academic burnout and as the variable through which the indirect association between mindfulness and academic burnout was examined.

Cognitive Avoidance Questionnaire: Cognitive avoidance was assessed using the Cognitive Avoidance Questionnaire, whose English version was validated by Sexton and Dugas [5]. The instrument uses a 5-point Likert response format and assesses five dimensions of cognitive avoidance: thought suppression, thought substitution, distraction, avoidance of threatening situations, and transformation of images into verbal thoughts.

Previous Iranian research [29] reported a Cronbach's alpha coefficient of 0.83 for the questionnaire. In the present study, internal consistency was 0.81, indicating acceptable reliability.

The five dimensions were incorporated as indicators of the cognitive avoidance construct in the structural model.

Academic Burnout Questionnaire: Academic burnout was assessed using the student burnout instrument developed by Schaufeli et al. [1]. The questionnaire contains 15 items across three dimensions: academic exhaustion (5 items), academic disengagement/cynicism (4 items), and academic inefficacy (6 items). Items were rated on a seven-point response scale as administered in the present study, with higher scores indicating greater academic burnout.

In an Iranian study [30], Cronbach's alpha coefficients of 0.63, 0.74, and 0.80 were reported for academic exhaustion, disengagement, and academic inefficacy, respectively, with an overall reliability coefficient of 0.79. In the present study, Cronbach's alpha coefficients for the three dimensions were 0.85, 0.78, and 0.75, respectively.

Academic burnout constituted the principal outcome variable in the proposed structural model.

Mindfulness Questionnaire: Mindfulness was assessed using the 15-item measure developed by Brown and Ryan [16]. Responses were coded from 1 (almost never) to 6 (almost always), with higher scores reflecting greater mindfulness. Previous Iranian research [31] reported Cronbach's alpha coefficients ranging from 0.80 to 0.87. In the present sample, Cronbach's alpha was 0.78.

Mindfulness was conceptualized as a protective cognitive factor in the proposed model. Its direct association with academic burnout was examined, together with its association with cognitive fusion

and its indirect association with academic burnout through cognitive fusion.

Cognitive Distortions Questionnaire: Cognitive distortions were assessed using the questionnaire developed by Abdollahzadeh and Salar [32]. The instrument uses a 5-point Likert response format ranging from 1 (strongly disagree) to 5 (strongly agree) and assesses ten dimensions of cognitive distortion: all-or-nothing thinking, overgeneralization, mental filtering, discounting the positive, jumping to conclusions/fortune-telling, magnification and minimization, emotional reasoning, should statements, labeling, and personalization. Each dimension is represented by two items.

The instrument development study reported a Cronbach's alpha coefficient of 0.80, while Veisi et al. [10] reported a reliability coefficient of 0.89. In the present study, Cronbach's alpha was 0.71.

The ten dimensions were incorporated as indicators of the latent cognitive distortions construct in the structural model.

Statistical analysis

Incomplete questionnaires were excluded before analysis. Descriptive statistics summarized participant characteristics, and correlation analyses examined associations among the study variables and their dimensions.

Structural equation modeling (SEM) was used to evaluate the proposed model of cognitive correlates of academic burnout. Parameters were estimated using maximum likelihood estimation. Model fit was evaluated using the chi-square statistic and degrees of freedom, the chi-square-to-degrees-of-freedom ratio, Goodness-of-Fit Index (GFI), Adjusted Goodness-of-Fit Index (AGFI), Comparative Fit Index (CFI), and Root Mean Square Error of Approximation (RMSEA).

Standardized regression coefficients, standard errors, critical ratios, and corresponding p values were used to evaluate the structural relationships. The model examined the direct associations of cognitive avoidance, cognitive distortions, mindfulness, and cognitive fusion with academic burnout, as well as the association between mindfulness and cognitive fusion. The indicators representing the cognitive avoidance and cognitive distortion constructs were also evaluated within the structural model.

The indirect association between mindfulness and academic burnout through cognitive fusion was examined using the Sobel test. Squared multiple correlations (R^2) were calculated for the endogenous variables, including academic burnout and cognitive fusion.

To examine whether laterality moderated the structural relationships, a multigroup structural equation modeling analysis was conducted. The bilateral/mixed group was excluded from this comparison, and the two lateralized groups were compared. An unconstrained model, in which structural paths were freely estimated across groups, was compared with a constrained model in which the corresponding paths were fixed to equality across groups. Moderation was evaluated by comparing the chi-square values and degrees of freedom of the constrained and unconstrained models. A statistically significant

chi-square difference would indicate that one or more structural relationships differed across laterality groups, whereas a nonsignificant difference would support equivalence of the structural paths across groups

Use of generative artificial intelligence

During manuscript preparation in August 2026, ChatGPT (OpenAI; GPT-5.6 Sol) was used for English-language drafting and editing, manuscript organization, reference-formatting and verification support, and arithmetic consistency checks of reported summary statistics. The tool was not used to generate or alter study data. All AI-assisted outputs were reviewed and verified by the authors against published references and available study records, and the authors take full responsibility for the final content. No raw or identifiable participant-level data were provided to the tool; only manuscript text and aggregate statistics were processed.

Results

Participant characteristics and preliminary associations

A total of 333 completed questionnaires were analyzed. Among participants included in the laterality-based comparison, 62% were female and 38% were male, and 76.68% were aged 19–22 years.

The correlation analysis indicated statistically significant associations among the study variables and their dimensions. Among the main cognitive variables associated with academic burnout, cognitive fusion showed the strongest reported correlation with burnout ($r = 0.211$). Among the dimensions of cognitive distortions, jumping to conclusions/fortune-telling showed the strongest intercorrelation with the overall cognitive distortion construct ($r = 0.636$), whereas labeling showed the weakest ($r = 0.512$). Among the dimensions of cognitive avoidance, avoidance of threatening situations showed the strongest association with the overall cognitive avoidance construct ($r = 0.601$), whereas thought substitution showed the weakest ($r = 0.532$).

Structural model fit

Structural equation modeling was used to evaluate the proposed model. The chi-square test was significant, $\chi^2(153) = 310.352$, $p < .001$, with $\chi^2/df = 2.03$. The remaining fit indices indicated acceptable fit (GFI = .946, AGFI = .925, CFI = .974, RMSEA = .043). Model-fit indices are presented in Table 1.

Table 1
Fit indices for the structural model

Fit index	Value
χ^2	310.352
df	153
χ^2/df	2.03
p	< .001
GFI	.946
AGFI	.925
CFI	.974
RMSEA	.043

Direct structural associations

The structural model indicated that all four cognitive variables were significantly associated with academic burnout. Cognitive distortions showed the strongest positive association with academic burnout (β = 0.179, CR = 4.350, p < .001), followed by cognitive fusion (β = 0.159, CR = 3.940, p < .001) and cognitive avoidance (β = 0.133, CR = 3.207, p = .001). In contrast, mindfulness was negatively associated with academic burnout (β = −0.125, CR = − 2.943, p = .003).

Mindfulness was also significantly and negatively associated with cognitive fusion (β = −0.170, CR = − 4.120, p < .001), indicating that higher mindfulness was associated with lower cognitive fusion. The principal structural associations are summarized in Table 2.

Table 2
Structural associations with academic burnout and cognitive fusion

Structural path	β	CR	SE	*p*
Cognitive avoidance → Academic burnout	.133	3.207	.027	.001
Cognitive distortions → Academic burnout	.179	4.350	.078	< .001
Mindfulness → Academic burnout	−.125	−2.943	.022	.003
Cognitive fusion → Academic burnout	.159	3.940	.033	< .001
Mindfulness → Cognitive fusion	−.170	−4.120	.027	< .001

The standardized loadings of the ten cognitive distortion dimensions ranged from 0.519 to 0.643. Jumping to conclusions/fortune-telling showed the highest standardized loading (β = 0.643), whereas

labeling showed the lowest loading (β = 0.519). All loadings were statistically significant at p < .001.

The standardized loadings of the five cognitive avoidance dimensions ranged from 0.535 to 0.599. Avoidance of threatening situations showed the highest loading (β = 0.599), closely followed by distraction (β = 0.598), whereas thought substitution showed the lowest loading (β = 0.535). All five indicators were statistically significant at p < .001.

Indirect association of mindfulness with academic burnout

In addition to the direct associations, the indirect association between mindfulness and academic burnout through cognitive fusion was examined using the Sobel test. The indirect association was statistically significant (β = −0.027, CR = − 3.826, p = .0006), indicating that higher mindfulness was associated with lower cognitive fusion, which in turn was associated with lower academic burnout. The indirect association is reported in Table 3.

Table 3
Indirect association between mindfulness and academic burnout

Indirect pathway	Standardized indirect effect	Sobel CR	*p*
Mindfulness → Cognitive fusion → Academic burnout	−.027	−3.826	.0006

Explained variance

The structural model explained 10.2% of the variance in academic burnout (R^2 = 0.102) and 2.9% of the variance in cognitive fusion (R^2 = 0.029). Among the observed indicators, the largest proportion of explained variance was found for the jumping to conclusions/fortune-telling dimension of cognitive distortions (R^2 = 0.413). Explained variance for the principal endogenous variables is presented in Table 4.

Table 4
Explained variance for the principal endogenous variables

Endogenous variable	R^2
Academic burnout	.102
Cognitive fusion	.029

The standardized structural model is presented in Fig. 1.

Multigroup analysis across laterality groups

A multigroup structural equation modeling analysis examined whether the structural relationships differed across the two laterality groups. The unconstrained model yielded χ^2 = 319.441 with 306

degrees of freedom, whereas the constrained model yielded $\chi^2 = 320.297$ with 326 degrees of freedom. The difference was $\Delta\chi^2(20) = 0.856$, $p > .999$, indicating that constraining the structural paths to equality did not significantly worsen model fit. The multigroup model comparison is presented in Table 5.

Table 5
Multigroup comparison of the structural model

Model	χ^2	df	p
Unconstrained model	319.441	306	—
Constrained model	320.297	326	—
Difference	0.856	20	> .999

Thus, no statistically significant moderating effect of laterality group was supported.

Despite the absence of an overall moderating effect, the principal structural associations remained statistically significant in laterality group 1. Cognitive avoidance (β = .137, p = .019), cognitive distortions (β = .182, p = .002), cognitive fusion (β = .161, p = .005), and mindfulness (β = −.125, p = .039) were associated with academic burnout, and mindfulness was negatively associated with cognitive fusion (β = −.171, p = .003).

A similar pattern was observed in laterality group 2. Cognitive avoidance (β = .129, p = .029), cognitive distortions (β = .176, p = .003), cognitive fusion (β = .158, p = .006), and mindfulness (β = −.126, p = .037) were associated with academic burnout, and mindfulness was negatively associated with cognitive fusion (β = −.170, p = .004). Group-specific structural coefficients are presented in Table 6.

Table 6
Principal structural paths across the two laterality groups

Structural path	Laterality group 1 β	*p*	Laterality group 2 β	*p*
Cognitive avoidance → Academic burnout	.137	.019	.129	.029
Cognitive distortions → Academic burnout	.182	.002	.176	.003
Mindfulness → Academic burnout	−.125	.039	−.126	.037
Cognitive fusion → Academic burnout	.161	.005	.158	.006
Mindfulness → Cognitive fusion	−.171	.003	−.170	.004

Overall, the pattern and magnitude of the principal structural associations were highly similar across the two groups, consistent with the nonsignificant multigroup comparison.

Discussion

The present study examined a structural model of cognitive correlates of academic burnout among medical students. The findings indicated that cognitive distortions, cognitive fusion, and cognitive avoidance were positively associated with academic burnout, whereas mindfulness was negatively associated with burnout. Among the cognitive risk factors, cognitive distortions showed the strongest direct association with academic burnout, followed by cognitive fusion and cognitive avoidance. Mindfulness was also negatively associated with cognitive fusion, and cognitive fusion accounted for a small but statistically significant indirect association between mindfulness and academic burnout. In addition, the pattern of structural relationships did not significantly differ across the two handedness-based laterality groups.

Cognitive distortions showed the strongest positive association with academic burnout in the structural model. This finding is consistent with previous studies reporting relationships between distorted cognitive processing and burnout-related outcomes [8–12]. Cognitive distortions may contribute to academic burnout by shaping how students interpret demanding academic experiences. When academic setbacks, examinations, or uncertainty about future performance are repeatedly interpreted through rigid or negatively biased cognitive patterns, these interpretations may intensify psychological strain and undermine academic motivation.

Among the dimensions of cognitive distortions, jumping to conclusions/fortune-telling showed the highest standardized loading, whereas labeling showed the lowest. This pattern may be particularly relevant in medical education, where students frequently encounter high-stakes assessments, competition, and uncertainty regarding future academic and professional performance. Negative predictions about future performance may therefore become especially salient. However, because the present study was cross-sectional, these findings should be interpreted as associations rather than evidence that cognitive distortions cause subsequent academic burnout.

Cognitive fusion also showed a significant positive association with academic burnout. This finding is consistent with previous work linking cognitive fusion with maladaptive psychological functioning and burnout-related processes [6, 10, 12]. Cognitive fusion reflects a tendency to become entangled with the literal content of thoughts, such that thoughts may be experienced as equivalent to reality rather than as transient mental events. In an academic context, a student who strongly fuses with thoughts such as “I will fail” or “I am not capable of succeeding” may experience those thoughts as factual representations of the situation. Such cognitive entanglement may be accompanied by persistent exhaustion, disengagement, and feelings of academic inefficacy.

Cognitive avoidance was likewise positively associated with academic burnout. Students who relied more strongly on avoidance-related strategies—including thought suppression, distraction, thought substitution, and avoidance of threatening situations—reported higher levels of burnout. This finding is broadly consistent with previous studies linking cognitive avoidance to burnout-related outcomes [6, 7]. Among the cognitive avoidance dimensions, avoidance of threatening situations showed the highest loading. This may indicate that withdrawal from or avoidance of stressful academic experiences is an

important component of the broader cognitive avoidance pattern observed in these students. Although avoidance may provide short-term relief from academic stress, repeated reliance on such strategies may coincide with reduced engagement with academic demands.

In contrast to these cognitive risk factors, mindfulness was negatively associated with academic burnout. This finding is consistent with previous studies showing that greater mindfulness is associated with lower burnout and that mindfulness-based interventions may alleviate academic burnout in medical students [18–20]. Greater present-moment awareness and a less judgmental orientation toward internal experiences may help students relate to academic stressors without automatically escalating negative interpretations or responses. Nevertheless, because the present data were collected at one point in time, mindfulness should be described as a protective correlate rather than as a demonstrated causal protective mechanism.

An important finding was the negative association between mindfulness and cognitive fusion. Students with higher mindfulness tended to report lower levels of cognitive fusion. This result is consistent with previous studies examining the relationship between mindfulness and cognitive fusion [22–24]. From a psychological flexibility perspective, mindfulness may allow individuals to observe negative academic thoughts without becoming fully identified with them. Thus, rather than treating a thought of failure as equivalent to actual failure, a more mindful student may experience it as a temporary mental event.

The significant indirect association between mindfulness and academic burnout through cognitive fusion further supports the relevance of this pathway. Higher mindfulness was associated with lower cognitive fusion, which in turn was associated with lower academic burnout. However, the magnitude of this indirect association was small ($\beta = -0.027$), and the cross-sectional design prevents temporal mediation from being established. Accordingly, this finding is better interpreted as evidence of an indirect statistical association consistent with a mediational pathway, rather than proof of a causal mediation mechanism.

The second objective of the study was to examine whether the structural associations differed across handedness-based laterality groups. The multigroup analysis indicated that constraining the structural paths to equality did not significantly worsen model fit, suggesting that the overall pattern of associations was statistically comparable across the two groups. The direct associations of cognitive avoidance, cognitive distortions, cognitive fusion, and mindfulness with academic burnout remained significant in both groups, and the standardized coefficients were highly similar.

This finding should be interpreted carefully. The grouping variable was derived from the Edinburgh Handedness Inventory and therefore represents handedness-based laterality rather than a direct neurophysiological measure of hemispheric activation. Consequently, the nonsignificant group difference should not be interpreted as evidence that neural hemispheric activity has no moderating role in academic burnout. Rather, the findings indicate that the proposed cognitive model did not differ significantly across the handedness-based laterality groups used in this study. Future studies specifically examining hemispheric activity should use direct neurophysiological measures.

Finally, the model explained 10.2% of the variance in academic burnout, indicating that the cognitive variables included in the model account for a meaningful but limited proportion of individual differences in burnout. Academic burnout is likely associated with a broader set of psychological, educational, social, and health-related factors not included in the present model. Future models could therefore incorporate additional contextual and health-related correlates, including social support and sleep quality.

Limitations

Several limitations should be considered when interpreting the findings of this study. First, all psychological variables were assessed using self-report questionnaires, which may have introduced response bias, including socially desirable responding and shared-method variance. Future studies may strengthen the assessment of these constructs by combining self-report measures with interviews, behavioral assessments, or other complementary methods.

Second, the study employed a cross-sectional design. Therefore, although the structural model identifies statistically significant associations among cognitive avoidance, cognitive distortions, cognitive fusion, mindfulness, and academic burnout, the temporal ordering and causal direction of these relationships cannot be established. Longitudinal or prospective studies are needed to determine whether these cognitive characteristics precede changes in academic burnout or whether burnout itself contributes to changes in cognitive functioning.

Third, the sample was restricted to general medical students from Shiraz University of Medical Sciences, which limits the generalizability of the findings to students from other academic disciplines, universities, educational levels, or cultural settings. Future studies should replicate the model in more heterogeneous samples, including students from the humanities, engineering, and other health-related disciplines, as well as postgraduate populations.

Fourth, the proposed model explained 10.2% of the variance in academic burnout, indicating that a substantial proportion of burnout remains unexplained by the cognitive variables included in the present study. Other potentially relevant factors, such as social support, sleep quality, academic workload, educational climate, and other psychological or contextual characteristics, should therefore be incorporated into future models.

Finally, laterality was assessed using the Edinburgh Handedness Inventory, which measures hand preference rather than direct neural activation. Consequently, the present multigroup findings should not be interpreted as evidence regarding functional hemispheric activity. Future studies specifically interested in brain lateralization and academic burnout should consider objective neurophysiological methods, such as electroencephalography (EEG) or functional magnetic resonance imaging (fMRI), during exposure to academically relevant stimuli.

Practical implications

Despite these limitations, the findings may have practical relevance for psychological and counseling services in medical universities. The structural model suggests that cognitive distortions, cognitive fusion, and cognitive avoidance are associated with greater academic burnout, whereas mindfulness is associated with lower burnout. Accordingly, university counseling programs may consider assessing these cognitive processes when identifying students who experience elevated academic burnout.

Future intervention research could evaluate mindfulness-based approaches, including Mindfulness-Based Stress Reduction (MBSR) practices such as mindful breathing and body scanning, as well as approaches aimed at reducing cognitive avoidance. Such interventions should be evaluated prospectively rather than inferred from the present cross-sectional associations.

Cognitive restructuring and cognitive defusion may also warrant evaluation as intervention targets for students who show persistent cognitive distortions or cognitive fusion. Examples include structured identification and evidence-based reconsideration of distorted interpretations and defusion exercises that help students observe negative thoughts without treating them as literal facts.

However, because the present study was observational and cross-sectional, these findings do not demonstrate that such interventions will reduce academic burnout. Rather, the identified cognitive variables represent potential targets that should be evaluated in future randomized or longitudinal intervention studies.

Implications for future research

Future research should first replicate the proposed structural model using longitudinal designs to clarify the temporal relationships among mindfulness, cognitive fusion, cognitive avoidance, cognitive distortions, and academic burnout. Studies incorporating multiple methods of assessment would also help reduce the limitations associated with exclusive reliance on self-report data.

Replication across different universities, academic disciplines, and educational levels is also warranted to evaluate the external validity of the model. Finally, if the role of brain lateralization is to remain part of this research program, future investigations should replace handedness-based grouping with direct measures of neural functioning, including EEG or fMRI.

Conclusions

This study examined a structural model of cognitive correlates of academic burnout among medical students. Cognitive distortions, cognitive fusion, and cognitive avoidance were positively associated with academic burnout, whereas mindfulness was negatively associated with burnout. Among the cognitive correlates, cognitive distortions showed the strongest direct association with academic burnout.

Mindfulness was also negatively associated with cognitive fusion, and cognitive fusion accounted for a small but statistically significant indirect association between mindfulness and academic burnout. These findings suggest that lower cognitive fusion may represent one psychological pathway through

which mindfulness is associated with lower levels of academic burnout. However, because the study was cross-sectional, this pathway should be interpreted as a statistical association rather than evidence of causal mediation.

The multigroup analysis further indicated that the structural relationships did not differ significantly across the two handedness-based laterality groups. Therefore, within the limits of the present measurement approach, the proposed cognitive model appeared to operate similarly across the two laterality groups.

Overall, the findings highlight cognitive distortions, cognitive fusion, cognitive avoidance, and mindfulness as potentially relevant psychological correlates of academic burnout among medical students. These variables may provide useful targets for future preventive and intervention research. Nevertheless, longitudinal and experimental studies are required to establish temporal and causal relationships and to determine whether modifying these cognitive processes can reduce academic burnout.

Abbreviations

AGFI
Adjusted Goodness-of-Fit Index
CFI
Comparative Fit Index
EEG
Electroencephalography
fMRI
Functional Magnetic Resonance Imaging
GFI
Goodness-of-Fit Index
LQ
Laterality Quotient
MBSR
Mindfulness-Based Stress Reduction
RMSEA
Root Mean Square Error of Approximation
SEM
Structural Equation Modeling

Declarations

Ethics approval and consent to participate

The study protocol was reviewed and approved by the Research Ethics Committees of Shiraz University of Medical Sciences (approval code IR.SUMS.REC.1400.284; approval date 13 June 2021). The study was conducted in accordance with the ethical principles and national standards governing medical research in Iran. Informed consent was obtained from all participants before participation. Participation was voluntary, and participants could decline or discontinue participation without penalty.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Author Contribution

S.T.: conceptualization, statistical analysis, interpretation, and supervision. M.H.S.: conceptualization, methodology, statistical analysis, interpretation, and supervision. M.H.A.H.: conceptualization, data collection, statistical analysis, drafting, and critical revision. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Figures

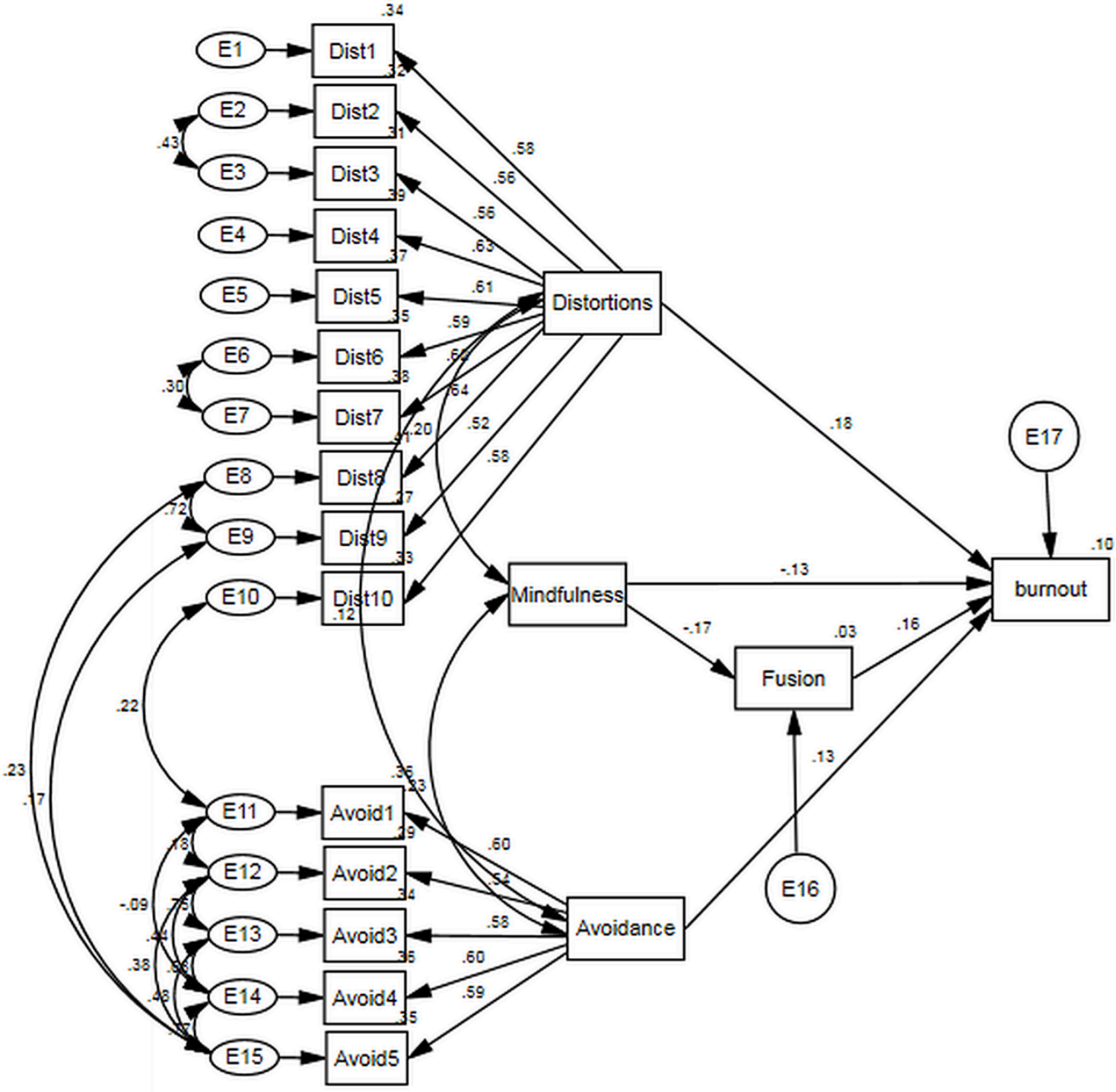


Figure 1

Standardized structural model of cognitive factors associated with academic burnout among medical students.