



Predicting Anxiety in Female Students Based on Mindfulness and Social Self-Efficacy: A Multilayer Perceptron Model

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Abstract

Background and Objective: Anxiety is a significant concern among students, impacting their academic performance and overall well-being. Understanding the factors that contribute to anxiety in this population is crucial for developing effective interventions. This study aims to explore the predictive relationship between mindfulness, social self-efficacy, and anxiety in female students aged 16–18 years. The findings are intended to offer valuable insights for educators and mental health professionals to design targeted interventions.

Methods: This study employed a descriptive-correlational design. The sample consisted of 215 female high school students residing in Ahvaz, Iran, during the 2022-2023 academic year. A multi-stage cluster sampling method was utilized to select participants. Data were collected through the Beck Anxiety Inventory (BAI), Five Facet Mindfulness Questionnaire (FFMQ), and Perceived Social Self-Efficacy Scale. The data analysis utilized a variety of methods, including Pearson's correlation coefficients, multiple regression analysis, and a multilayer perceptron model.

Findings: The findings revealed a strong negative correlation between mindfulness and anxiety ($r=-0.60$, 95% CI [-0.68, -0.51], $P<0.001$) and between social self-efficacy and anxiety ($r=-0.51$, $P<0.001$). A multiple regression relationship was observed between mindfulness, social self-efficacy, and anxiety ($P<0.001$). The multilayer perceptron model identified social self-efficacy as the strongest predictor of anxiety.

Conclusion: This study demonstrated that both mindfulness and social self-efficacy were strongly and negatively associated with anxiety levels in female students, with social self-efficacy emerging as the strongest predictor. These results highlight the potential of interventions that foster mindfulness practices and enhance social self-efficacy to mitigate anxiety, offering practical implications for improving mental health in educational and clinical settings.

Keywords: Anxiety, Mindfulness, Self-efficacy, Students

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1. Introduction

During their developmental years, female high school students are particularly vulnerable to various emotional and behavioral challenges (1). Research indicates that 14–24% of adolescents experience behavioral and emotional issues or disorders (2). Early childhood behavioral difficulties often precede antisocial behaviors in late adolescence, adversely affecting academic performance, social interactions, and overall well-being in educational settings (3). Anxiety disorders, characterized by persistent and pervasive symptoms, may emerge during mid-to-late adolescence, significantly disrupting academic progress and social development (4). Although some anxieties are developmentally normative, meaning they are typical and expected during specific developmental stages, these disorders often manifest early and can persist into adulthood if not addressed (5). This study focuses on female students due to their heightened susceptibility to anxiety, driven by gender-specific social pressures, such as societal expectations, and psychological factors, including sensitivity to interpersonal dynamics, which necessitate targeted research to inform tailored interventions.

While anxiety is a necessary response to specific situations, it becomes problematic when individuals cannot anticipate future events or their own behaviors, or when they perceive their efforts as futile and events as beyond their control (6). Persistent anxiety can lead to chronic tension, stress, and nervousness. When attempts to address or cope with challenges fail, anxiety intensifies, reducing cognitive flexibility and limiting consideration of alternative solutions (7). Ineffective anxiety management reflects an individual's difficulty in handling pressure, with anxiety control significantly influencing its severity (8). While some psychological pressures are normative, such as those experienced during school transitions or navigating social and personal identity (9), anxiety levels vary widely. Simple anxieties, like fear of the dark or pre-exam nerves, contrast with more intense forms, such as those triggered by learning new skills or engaging in stimulating activities (10). These variations underscore the complex nature of anxiety in shaping individual experiences and responses.

Mindfulness can be identified as one of the factors influencing anxiety in female students (11). Anxiety in students can stem from various factors, including individual and social characteristics (12). One individual dimension that plays a significant role in the manifestation of anxiety is mindfulness (13).

Mindfulness refers to an individual's ability to identify and understand their own feelings, thoughts, and behaviors. This characteristic can directly affect how adolescents confront stressful and anxiety-provoking situations (14, 15). Students with higher levels of mindfulness are typically able to identify their emotions and feelings more accurately and, as a result, may be more susceptible to the influence of anxiety. This awareness of feelings and thoughts can lead adolescents to dwell on problems and negative issues more than necessary, which, in turn, can contribute to the exacerbation of anxiety (16).

Another factor that appears to influence anxiety is social self-efficacy (17). Self-efficacy is defined as an individual's beliefs about successfully performing a behavior. It reflects the individual's confidence in their ability to control their feelings, emotions, and behaviors, and to influence the consequences of events (18). According to Bandura's self-efficacy theory, self-efficacy serves as a cognitive mediator that shapes perceptions of control in challenging situations, with low self-efficacy increasing vulnerability to anxiety by fostering feelings of helplessness. Individuals with strong beliefs in their abilities demonstrate greater effort and persistence in completing their tasks, whereas those who doubt their abilities tend to abandon tasks and give up. Therefore, self-efficacy can be considered a driving force for individuals (19). Social self-efficacy serves as a fundamental need in facilitating an individual's social adjustment. An individual's performance is influenced by their social self-efficacy and reflects their self-perception, which may be formed through comparisons with others or independently of them (20). Indeed, it can be stated that effective performance requires both possessing the necessary skills and believing in one's ability to execute those skills (21). Students with lower social self-efficacy often experience feelings of inadequacy in social contexts, leading to avoidance behaviors that may heighten social anxiety. This is consistent with Bandura's framework which emphasizes the role of self-efficacy in mitigating anxiety through perceived competence.

Students with lower social self-efficacy often experience feelings of inadequacy in social contexts, leading to avoidance behaviors that may heighten social anxiety. Factors such as ineffective communication, negative self-judgment, and fear of rejection can intensify this anxiety. Examining the interplay between mindfulness, social self-efficacy, and anxiety in students elucidates the psychological

mechanisms underlying anxiety's emergence, informing effective prevention and treatment strategies. During development, students encounter significant physical, social, and psychological changes that exert considerable pressure. While anxiety is a natural response to these changes, its intensification or chronicity can lead to serious issues. Research suggests that students with high mindfulness may experience increased anxiety, as heightened awareness of negative thoughts and emotions can amplify sensitivity in stressful situations. Thus, identifying predictors of anxiety in students is critical.

2. Objectives

This study aimed to investigate the predictive relationship between mindfulness, social self-efficacy, and anxiety in female students. The findings of this study are expected to inform the development of effective interventions for mitigating anxiety in female students within the educational setting.

3. Methods

This observational study employed a descriptive-correlational design to examine the relationships between mindfulness, social self-efficacy, and anxiety among female high school students in Ahvaz, Iran, during the 2022-2023 academic year. The target population consisted of all female students enrolled in public high schools in Ahvaz. A multi-stage cluster sampling method was used to select participants. First, one of the four educational districts in Ahvaz was randomly chosen using a random number generator. From that district, three high schools were randomly selected. Finally, nine classes were chosen by lottery to ensure the sample was representative. The sample size was 215 female students. This number was determined using a power analysis for multiple regression models to ensure enough statistical power ($\alpha=0.05$, power=0.80) to detect moderate effect sizes. The study focused exclusively on female students to address their specific vulnerability to anxiety, influenced by gender-specific social and psychological factors, such as societal expectations and interpersonal sensitivities. Eligible participants were female students aged 16–18 years, enrolled in secondary education, with no diagnosed physical or mental illnesses, and who provided informed consent. Participants with incomplete questionnaires were identified by reviewing submissions for missing responses in any scale items, resulting in the exclusion of 12 participants from the analysis. Questionnaires were

administered over a two-week period in October 2022 during regular class hours to minimize disruption and ensure consistency. Data were collected using validated self-report questionnaires, including the Beck Anxiety Inventory (BAI), the Five Facet Mindfulness Questionnaire (FFMQ), and the Perceived Social Self-Efficacy Scale. Ethical approval was obtained from the Ethics Committee of Islamic Azad University, Ahvaz branch (code: IR.IAU.AHVAZ.REC.1403.224), with measures to ensure participant confidentiality and anonymity.

3.1. Instruments

3.1.1. Beck Anxiety Inventory (BAI)

Anxiety symptoms experienced within the past week were assessed using the 21-item Beck Anxiety Inventory (BAI) (22). This self-report measure utilizes a 4-point Likert scale (0 = "not at all" to 3 = "severely") to quantify the severity of anxiety symptoms, resulting in a total score ranging from 0 to 63. Higher scores on the BAI indicate higher levels of anxiety. Previous research has demonstrated robust internal consistency of the BAI, with Cronbach's alpha reported as 0.82 by Hossein Kaviani and Mousavi (23). In the present study, the BAI exhibited excellent internal consistency, with a Cronbach's alpha of 0.89.

3.1.2. Five Facet Mindfulness Questionnaire (FFMQ)

The participants' level of mindfulness was assessed using the Five Facet Mindfulness Questionnaire (FFMQ) (24), a 15-item self-report measure designed to evaluate the capacity for non-judgmental attention to present-moment experiences, distinguishing it from states such as rumination, worry, and automatic pilot. The FFMQ provides a comprehensive evaluation of mindfulness capacities by assessing five distinct facets of mindfulness: observing, describing, acting with awareness, non-judging of inner experience, and non-reactivity to inner experience. Responses were recorded on a 6-point Likert scale, yielding a total score ranging from 15 to 90, with higher scores indicative of greater mindfulness. Previous research has demonstrated robust internal consistency of the FFMQ, with reported Cronbach's alpha values of 0.86 (25). In the current study, the FFMQ exhibited strong internal consistency, with a Cronbach's alpha of 0.87.

3.1.3. Perceived Social Self-Efficacy Scale

The Social Self-Efficacy Scale was developed by Smith and Betz (26). This scale consists of 22 items that measure an individual's self-confidence in various social situations on a five-point scale. Responses to the items range from one (strongly disagree/no

confidence) to five (strongly agree/complete confidence), with the minimum and maximum possible scores being 22 and 110, respectively. The scale had already demonstrated strong internal consistency with a Cronbach's alpha of 0.82 (27). In this study, the Perceived Social Self-Efficacy Scale demonstrated robust internal consistency, with a Cronbach's alpha of 0.84.

3.1.4. Statistical analyses

Descriptive statistics, including means and standard deviations, were computed to characterize the study variables. Pearson's correlation coefficients were calculated to assess the strength and direction of relationships between mindfulness, social self-efficacy, and anxiety. A simultaneous multiple regression analysis was performed to evaluate the predictive effects of mindfulness and social self-efficacy on anxiety. The model included both predictor variables concurrently. Additionally, a multilayer perceptron (MLP) artificial neural network model was developed using MATLAB version 2019 to further explore the predictive accuracy of the independent variables. The dataset was split into training (70%), validation (15%), and testing (15%) subsets, with early stopping criteria

applied to prevent overfitting. All statistical analyses were conducted using SPSS version 27 and MATLAB version 2019, with a significance level set at $P < 0.05$.

4. Results

The sample consisted of 215 participants, with the following age breakdown: 29.77% were 16 years old, 37.67% were 17, and 32.56% were 18. Regarding their academic field of study, 27.44% were enrolled in mathematics and physics, 34.89% in humanities, and 37.67% in natural sciences. Table 1 displays the descriptive statistics and Pearson correlation coefficients for the variables of anxiety, mindfulness, and social self-efficacy. The mean scores were 23.19 (SD=5.30) for anxiety, 50.11 (SD=10.58) for mindfulness, and 71.74 (SD=18.05) for social self-efficacy. A strong negative correlation was observed between anxiety and mindfulness ($r = -0.60$, 95% CI [-0.68, -0.51], $P < 0.001$), indicating that higher mindfulness levels were associated with lower anxiety. Similarly, a strong negative correlation was found between anxiety and social self-efficacy ($r = -0.51$, $P < 0.001$), suggesting that greater social self-efficacy corresponded to reduced anxiety levels.

Table 1. Means, standard deviations (SD), and Pearson correlation coefficients for the study variables

VARIABLES	MEAN	SD	PEARSON CORRELATION COEFFICIENTS
ANXIETY	23.19	5.30	1
MINDFULNESS	50.11	10.58	-0.60**
SOCIAL SELF-EFFICACY	71.74	18.05	-0.51**

**; $P < 0.01$

A simultaneous multiple regression analysis was conducted to examine the predictive power of mindfulness and social self-efficacy on anxiety levels in students. Mindfulness and social self-efficacy were entered as predictor variables in the regression model. As presented in Table 2, the results revealed a

significant multiple correlation between the predictor variables and anxiety ($R = 0.67$, $P < 0.001$). Regression analysis further demonstrated that both mindfulness ($\beta = -0.32$, $P < 0.001$) and social self-efficacy ($\beta = -0.39$, $P < 0.001$) significantly and negatively predicted anxiety levels.

Table 2. Results of simultaneous multiple regression analysis

PREDICTOR VARIABLE	R	R ²	F	P	B	B	P
MINDFULNESS	0.67	0.45	41.50	0.001	-0.01	-0.32	0.001
SOCIAL SELF-EFFICACY					-0.31	-0.39	0.001
CONSTANT					38.63	-	0.001

Furthermore, an artificial neural network (ANN) was developed utilizing MATLAB to investigate the predictive accuracy of mindfulness and social self-efficacy on anxiety levels in female students. The dataset was divided into three subsets: a training set (70%), a validation set (15%), and a testing set (15%). Two input variables (mindfulness and social self-

efficacy) and one output variable (anxiety) were entered into the network in matrix format via an Excel file. Network performance was optimized through iterative training. The optimal network architecture, depicted in Figure 1, consisted of a two-hidden-layer configuration with five neurons in the first hidden layer and a single neuron in the second hidden layer.

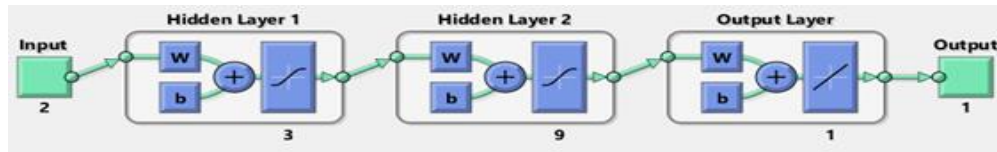


Figure 1. Schematic representation of the multilayer perceptron model with the highest accuracy

To prevent overfitting, an early stopping criterion was implemented with a threshold of no reduction in validation error below 0.001 for seven consecutive epochs. Training continued until no significant improvement in validation error was observed. As illustrated in Figure 2, the training process was halted after 13 epochs, where the validation error stabilized for

seven consecutive epochs. Figure 2 also demonstrates that: 1) the final mean squared error was minimal, 2) the error on the testing set demonstrated a trend consistent with that of the validation set, and 3) overfitting was not observed until after the optimal epoch (epoch 7) was reached.

Figure 2. Network Performance Diagram

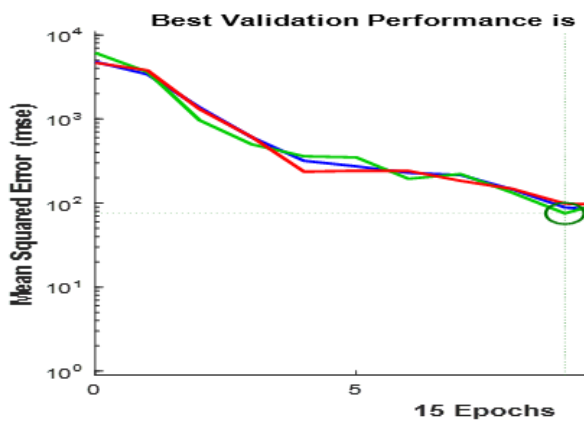


Figure 3 illustrates the relative importance of mindfulness and social self-efficacy as predictors of anxiety in female students, calculated using the connection weights method. According to the results,

social self-efficacy emerged as a more significant predictor of anxiety compared to mindfulness, consistent with the regression analysis findings.

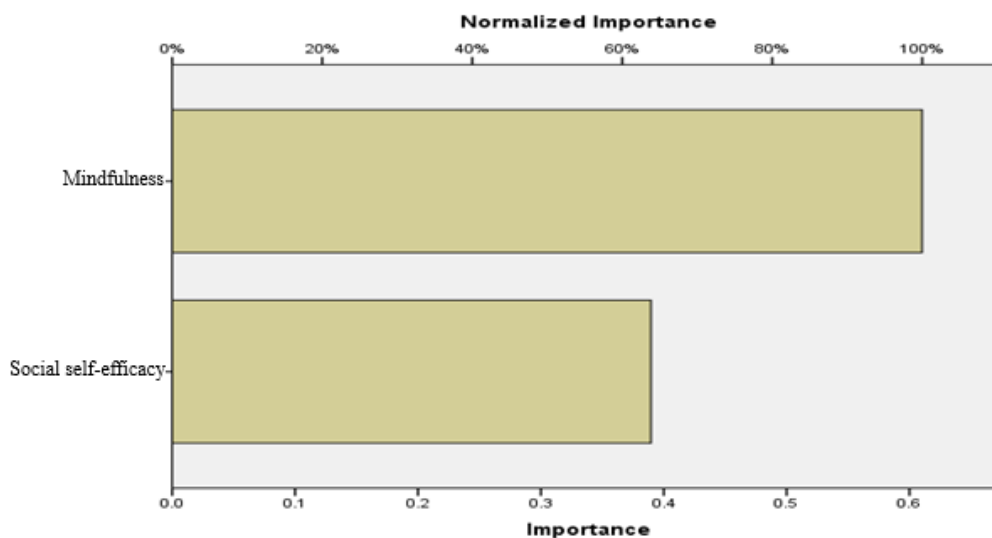


Figure 3. Relative importance of predictor variables

5. Discussion

This study investigated the predictive relationship between mindfulness, social self-efficacy, and anxiety

levels among female high school students in Ahvaz, Iran. Its aim was to enhance our understanding of the psychological factors contributing to anxiety (28). The

findings revealed a significant association between mindfulness, social self-efficacy, and anxiety, with these factors collectively accounting for 45% of the variance in anxiety levels among participants (29). The multilayer perceptron model identified social self-efficacy as the strongest predictor of anxiety, aligning with the regression analysis results. This resolves an earlier discrepancy in the manuscript where mindfulness was incorrectly reported as the strongest predictor, likely due to its stronger correlation coefficient. The significant negative relationship between mindfulness and anxiety is consistent with prior studies by Narimani et al. (28), Çalıřkan et al. (29), and Cortazar and Calvete (30). Mindfulness, defined as the ability to recognize and understand thoughts, feelings, and emotional reactions non-judgmentally, enables students to respond more effectively to stress and anxiety by enhancing emotion regulation and cognitive flexibility, as supported by neurocognitive models of attention regulation (30). During mid-to-late adolescence, female students experience numerous physiological and psychological changes that can heighten anxiety levels. Mindfulness serves as a protective factor by fostering adaptive coping strategies, such as cognitive reappraisal, which helps reduce anxious arousal by reframing stressors (30). The earlier claim that female students exhibit “exaggerated and irrational reactions” to their feelings lacks specific empirical support in this study and is more accurately described as heightened sensitivity to stressors due to developmental and social factors, such as peer pressure and gender-specific expectations. Students with high mindfulness are better equipped to become aware of their emotions and manage them effectively, thereby reducing the intensity of anxiety and improving their ability to cope with stressful situations (30). Studies indicate that mindfulness can act as a protective factor against anxiety, as self-aware individuals have a greater ability to process and analyze stressful situations. In other words, mindfulness helps students identify the source of their anxieties and find appropriate solutions to cope with them. This can lead to a reduction in anxious reactions and enhance psychological adjustment, defined as the ability to adapt to environmental demands and maintain emotional well-being, in the face of life’s challenges. Consequently, the stated hypothesis emphasizes that increasing the level of mindfulness can help reduce anxiety in female students, as this ability enables individuals to better understand their feelings and emotions and reduce the intensity of their psychological anxieties (28). Therefore, enhancing mindfulness in psychological and educational

programs can be considered an effective method for reducing anxiety in female students.

Another finding of the present study was that social self-efficacy had a significant negative relationship with anxiety in female students, which is consistent with the results of Falamarzi and Seif (31), and Hatami et al. (32). It can be stated that self-efficacy encompasses an individual’s judgments about their abilities, capacities, and capabilities to perform specific tasks. This skill forms the foundation of human agency and is a key resource for transformation, adaptation, and personal change (32). According to Bandura (33), self-efficacy is considered a factor that acts as a cognitive mediator, influencing individuals’ cognitions, thoughts, and feelings. Therefore, obtaining such a result is not unexpected, because when students are exposed to negative events or stressful situations, a high sense of self-efficacy helps them manage that event and, as a result, protect themselves against psychological problems (31). On the other hand, low self-efficacy cognitively hinders effective coping with stressful situations and increases pathological symptoms and psychological disorders. According to Bandura’s theory, individuals with high social anxiety often feel that they lack the specific skills and abilities necessary for interpersonal behavior and have low expectations of success in social situations (33). Social self-efficacy refers to an individual’s belief in their abilities to communicate effectively with others and solve social problems. Students with lower social self-efficacy may feel inadequate in social situations and avoid them, which can lead to increased social anxiety. Feelings of inability to communicate effectively, negative self-judgments, and fear of rejection are among the factors that can exacerbate social anxiety in students.

It can be concluded that anxiety is one of the most prevalent psychological problems among students, which can have serious effects on their mental health and quality of life. Rapid physical, psychological, and social changes during adolescence naturally lead to an increase in anxiety. However, when this anxiety escalates into a chronic disorder, it can impede students’ development and hinder their individual and social success. Understanding the factors that contribute to increased anxiety during this period can help develop strategies for managing and reducing anxiety.

The cross-sectional design of this study represents a notable limitation, as it precludes the ability to determine causal relationships or to assess the long-term impact of mindfulness on social self-efficacy and anxiety. The sample was limited to female high school

students in Ahvaz, and the results may not be generalizable to male students, other age groups, or different geographical regions. This study's reliance on self-report measures introduces a potential limitation, as the data may be subject to response biases or reporting tendencies. Furthermore, the research did not account for other variables that may impact anxiety levels, including socioeconomic status, family dynamics, or cultural influences. Finally, this study focused on adolescent girls, and therefore, gender differences in the experience of anxiety were not explored. To address these limitations, future research should employ longitudinal designs to examine causal relationships over time and include diverse populations to enhance generalizability. Additionally, incorporating objective measures, such as physiological indicators of anxiety, could reduce reliance on self-reports. Based on the findings, specific recommendations for interventions include integrating mindfulness-based programs, such as Mindfulness-Based Stress Reduction (MBSR), into school curricula to enhance students' ability to manage stress and emotions. Similarly, social skills training programs aimed at improving social self-efficacy, such as workshops on effective communication and conflict resolution, could be implemented in educational settings to reduce anxiety among female adolescents.

6. Conclusion

The findings of this study provide significant insights into the relationship between mindfulness, social self-efficacy, and anxiety in female high school students in Ahvaz, Iran. The results demonstrated strong negative correlations between both mindfulness and social self-efficacy with anxiety levels, indicating that higher levels of these factors are associated with lower anxiety. Furthermore, the presence of a multiple regression relationship between these variables underscores the complex interplay of intrapersonal and interpersonal factors in influencing adolescent emotional well-being. The multilayer perceptron model analysis highlighted social self-efficacy as the most significant predictor of anxiety within this cohort, emphasizing its critical role in mitigating anxiety. These findings underscore the importance of fostering mindfulness practices, such as through structured programs like Mindfulness-Based Stress Reduction (MBSR), and enhancing social self-efficacy through targeted social skills training, such as workshops on communication and interpersonal confidence, in educational settings to promote mental health and well-being among adolescent girls.

Footnotes

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Conflict of Interests Statement

The authors declare no conflict of interest.

Data Availability

All data generated or analyzed in this study are available from the corresponding author upon reasonable request.

Funding/Support

The present study received no funding/support.

Ethical Approval

The study was approved by the Ethics Committee of Islamic Azad University, Ahvaz branch (code: IR.IAU.AHVAZ.REC.1403.224).

Authors' Contribution

M. M. developed the study concept and design. M.M. and B. B. M. acquired the data. M. M. analyzed and interpreted the data, and wrote the first draft of the manuscript. All authors contributed to the intellectual content, manuscript editing and read and approved the final manuscript. B. B. M. provided administrative support.

Informed Consent

All participants provided written informed consent prior to their inclusion in the study, with parental or guardian consent obtained for participants under 18 years of age, in accordance with ethical guidelines.

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