Mental Health and Lifestyle Journal

Year 2026
Volume 4
Issue 1

The Structural Model of the Mediating Role of Mindfulness in the Relationship Between Grit and Lifelong Learning in Middle-Aged Adults

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Article type:
Original Research

Article history:
Received 09 March 2025
Revised 13 August 2025
Accepted 21 August 2025
Published online 01 January 2026

ABSTRACT

The present study aimed to examine the mediating role of mindfulness in the relationship between grit and lifelong learning among middle-aged adults. The research method was descriptive, and the design was correlational using structural equation modeling. The statistical population included all middle-aged employees working in the Islamshahr district of Tehran, among whom 527 individuals were selected through random sampling. Participants completed the Grit Scale, the Mindfulness Questionnaire, and the Lifelong Learning Scale. The reliability and validity of the instruments were confirmed using Cronbach's alpha coefficients and confirmatory factor analysis. Data were analyzed through the structural equation modeling method using AMOS software. The results showed that the direct effect of grit on mindfulness and lifelong learning in middle-aged adults was positive and significant. Mindfulness also had a positive and significant direct effect on lifelong learning. Furthermore, mindfulness played a positive and significant mediating role in the effect of self-balance on lifelong learning among middle-aged adults. Therefore, it can be concluded that grit, through the mediation of mindfulness, influences lifelong learning and contributes to the improvement of lifelong learning among middle-aged adults.

Key words: Grit, Mindfulness, Lifelong Learning, Middle-Aged Adults

How to cite this article:
Falah Tafti, S., Davoodi, A., & Tabarraei, R. (2026). The Structural Model of the Mediating Role of Mindfulness in the Relationship Between Grit and Lifelong Learning in Middle-Aged Adults. *Mental Health and Lifestyle Journal, 4*(1), 1-13. https://doi.org/10.61838/mhlj.129

Introduction

In the rapidly evolving landscape of the 21st century, lifelong learning has emerged as a foundational pillar for personal growth, social inclusion, and professional adaptability. It is defined as a continuous, self-motivated process of acquiring knowledge and skills throughout the lifespan, encompassing formal, non-formal, and informal contexts (1). As societies face unprecedented technological, economic, and demographic transformations, the capacity for individuals to engage in lifelong learning is increasingly viewed as essential for both employability and psychological well-being (2, 3). Among adults, particularly middle-aged workers, the motivation and perseverance required to sustain learning across life stages depend on complex psychological mechanisms such as grit, mindfulness, and self-regulatory processes (4, 5).

Lifelong learning is more than an educational policy ideal; it represents a psychological disposition toward self-improvement and adaptability (6). Research indicates that lifelong learning contributes to enhanced cognitive functioning, resilience, and subjective well-being among adults (4, 7). The World Development Report underscored that learning continuity is indispensable in responding to changing labor market demands and societal challenges (1). In higher education and professional domains, lifelong learning entails the ability to engage in self-directed inquiry, apply acquired knowledge to new problems, and sustain motivation despite obstacles (5, 8).

Psychological resources such as grit and mindfulness are recognized as key enablers of lifelong learning (9, 10). These constructs capture an individual's capacity to maintain perseverance, self-discipline, and reflective awareness, facilitating deeper engagement with the learning process. Grit, in particular, has been linked to academic persistence, goal attainment, and adaptability (11, 12). Mindfulness, by contrast, contributes to cognitive flexibility, emotional regulation, and attentional stability, all of which are essential for sustained learning in adulthood (13, 14).

Grit, conceptualized by Duckworth and colleagues as "perseverance and passion for long-term goals," represents a non-cognitive trait that predicts success beyond intellectual ability (11). Individuals with higher levels of grit are more likely to maintain effort and interest over time, even when faced with challenges or monotony (15). This quality is particularly relevant for middle-aged adults engaged in lifelong learning, as they must navigate competing demands such as work, family, and personal responsibilities (16). Studies have shown that grit supports consistent academic engagement and career advancement by promoting resilience and self-regulation (17, 18).

In educational contexts, grit has been associated with higher achievement, motivation, and self-regulated learning (12, 19). Grit enables learners to set long-term objectives and to persist through cognitive and emotional challenges inherent in lifelong education (20). Moreover, the multidimensional framework of grit—comprising perseverance of effort and consistency of interests—reflects not only determination but also sustained alignment between personal values and learning goals (21, 22). This suggests that grit may foster the psychological endurance necessary for continuous learning and adaptation across the lifespan (23).

Mindfulness, defined as a state of non-judgmental awareness of the present moment, has gained prominence as a psychological mechanism that enhances learning, mental health, and self-regulation (24, 25). Mindful individuals exhibit greater cognitive control, focus, and emotional stability, enabling them to process information more effectively and to cope with learning-related stress (26, 27). The Five Facet Mindfulness Model introduced by Baer et al. (2006) includes observing, describing, acting with awareness, nonjudging, and nonreactivity—components that directly contribute to cognitive engagement and self-awareness in educational settings (13).

Empirical studies highlight mindfulness as a significant predictor of well-being and academic success. For example, Cheung and Djekou (2024) demonstrated that mindfulness reduces mind-wandering and enhances grit and self-compassion, leading to improved learning focus (28). Similarly, Corti and Gelati (2020) found that mindfulness-based interventions improved university students' learning abilities and metacognitive awareness (29). Mindfulness also supports knowledge transfer and reflective learning, processes that are integral to adult education (30). By fostering self-observation and emotional balance, mindfulness facilitates adaptive responses to failure, which is critical for sustaining engagement in lifelong learning (27, 31).

Recent evidence suggests that mindfulness and grit are interconnected constructs that mutually reinforce one another in promoting persistence and well-being (10, 32). Mindfulness enhances grit by improving attentional regulation and reducing impulsivity, allowing individuals to maintain sustained effort toward long-term goals (28). Conversely, individuals high in grit may practice mindfulness more effectively because they demonstrate greater discipline and goal orientation (33).

Studies have shown that mindfulness-based training increases both perseverance and motivation, suggesting that mindfulness may serve as a mediator in the relationship between grit and learning outcomes (22). For instance, Fowler (2025) found that both grit and growth mindset predicted persistence in professional aviation training programs (16), while Lee and Jang (2018) reported that grit and mindset jointly enhanced hope and self-directed learning (34). This interplay implies that mindfulness may strengthen the link between grit and lifelong learning by cultivating self-regulated attention and emotional balance (35).

The role of lifelong learning in promoting psychological and cognitive well-being has been consistently documented (7, 23). Middle-aged adults who engage in continuous learning exhibit better mental health, higher life satisfaction, and improved adaptability to workplace changes (4). Lifelong learning not only supports employability but also enhances a sense of purpose and self-efficacy (2, 3).

Mindfulness acts as an important cognitive resource for lifelong learners, improving attention, metacognition, and stress management (19, 26). Through cultivating present-moment awareness, learners can better retain information, reflect on experiences, and regulate affective responses to challenges (36). In this regard, mindfulness functions as a form of "empowering knowledge" that transforms learning from a passive acquisition process into an active, reflective, and emotionally intelligent endeavor (30). Moreover, mindfulness can mitigate burnout and cognitive overload, helping adult learners sustain long-term engagement in learning environments (27).

The integration of self-discrepancy theory (37) with mindfulness and grit theories provides a valuable perspective for understanding lifelong learning motivation. Self-discrepancy theory posits that emotional discomfort arises from the gap between one's actual self and ideal self, which can drive individuals toward self-improvement. Mindfulness helps individuals accept these discrepancies nonjudgmentally, reducing anxiety and enhancing intrinsic motivation to learn (38). Similarly, grit channels this motivational tension into sustained effort, transforming discomfort into goal-oriented persistence (39).

In this context, lifelong learning represents an adaptive mechanism for reconciling self-discrepancies through continuous growth and self-development. This aligns with contemporary educational psychology models that emphasize self-determination, cognitive flexibility, and emotional regulation as determinants of sustainable learning (40, 41). Grit enables individuals to pursue long-term goals despite setbacks, while mindfulness enhances the awareness and self-compassion necessary to maintain motivation in the face of adversity (10, 24).

A growing body of evidence underscores the importance of grit and mindfulness as predictors of lifelong learning outcomes. For example, Zhao et al. (2024) demonstrated that grit indirectly influences learning engagement through mastery goal orientation and cognitive flexibility (40). Likewise, Schimschal et al. (2022) proposed an integrative model illustrating how grit operates as a psychological resource that sustains goal pursuit under uncertainty (21). However, despite robust findings in student and occupational samples,

relatively few studies have examined the interaction of grit, mindfulness, and lifelong learning among middle-aged adults—an age group facing unique cognitive and motivational challenges (3, 23).

Furthermore, while mindfulness-based interventions have been shown to enhance learning motivation and emotional resilience (26, 29), the mediating role of mindfulness in the relationship between grit and lifelong learning remains underexplored. Understanding this mediation could clarify how perseverance of effort translates into sustained cognitive engagement and continuous self-improvement (9).

The reviewed literature establishes a theoretical foundation for linking grit, mindfulness, and lifelong learning within a structural framework. Grit facilitates goal-oriented persistence, mindfulness enhances self-regulated attention and emotional stability, and lifelong learning serves as the behavioral outcome reflecting adaptive growth (6, 11, 13). Despite advances in understanding each construct independently, there remains a gap in modeling their interrelationships within adult populations. The present study addresses this gap by examining the mediating role of mindfulness in the relationship between grit and lifelong learning among middle-aged individuals.

Methods and Materials

Study Design and Participants

The present study employed a descriptive-correlational design using the structural equation modeling (SEM) approach, as the relationships among variables were examined within a causal framework. The statistical population of this study included middle-aged employees working in the Islamshahr district of Tehran. Considering that the study utilized the structural equation modeling approach, the sample size was determined based on the number of variables in the model. In general, for SEM analysis, it is recommended that between 5 and 15 observations be included per measured variable. Accordingly, 550 questionnaires were distributed among middle-aged employees in the district using a simple random sampling method. After removing incomplete questionnaires, 527 valid questionnaires were retained for the final analysis. This sample size was statistically and methodologically adequate for conducting structural equation modeling.

Data Collection

Grit was measured using the Grit Scale developed by Duckworth and Quinn (2009). This 12-item questionnaire assesses two dimensions: consistency of interests and perseverance of effort. Items are rated on a 5-point Likert scale ranging from "strongly disagree" (score 1) to "strongly agree" (score 5). Duckworth and Quinn (2009) reported the internal consistency reliability (Cronbach's alpha) of the scale as .82 and the test–retest reliability over one year as .68. The total score ranges from 12 to 60. Construct validity was established through factor analysis and internal consistency methods. Factor analysis with varimax rotation confirmed the presence of two factors—consistency of interest and perseverance of effort—that together explained 61.5% of the total variance. Cronbach's alpha coefficients were reported as .77 for consistency of interest and .83 for perseverance of effort. In the present study, Cronbach's alpha coefficients were .84 for consistency of interest, .81 for perseverance of effort, and .89 for the total scale, indicating satisfactory reliability. Confirmatory factor analysis (CFA) fit indices for the Grit Scale in the present study were GFI = 0.95, NFI = 0.97, CFI = 0.98, and RMSEA = 0.059, confirming the instrument's validity.

Mindfulness was measured using the Five Facet Mindfulness Questionnaire (FFMQ) developed by Baer et al. (2006). This 39-item instrument assesses five dimensions: observing (8 items), acting with awareness (8 items), nonjudging of inner experience (8 items), describing (7 items), and nonreactivity to inner experience (7 items). According to Neuser (2010), the internal consistency of the subscales is acceptable, with Cronbach's alpha coefficients ranging from .75 for nonreactivity to .91 for describing. The intercorrelations among the subscales were moderate and statistically significant (ranging from .15 to .34; Ahmadvand et al., 2012). In a validation study conducted in the Iranian population, test–retest reliability coefficients ranged from .57 for nonjudging to .84 for observing. Cronbach's alpha values ranged from .55 for nonreactivity to .83 for describing, demonstrating satisfactory reliability (Ahmadvand et al., 2012). In the present study, Cronbach's alpha coefficients were .79 for observing, .87 for acting with awareness, .87 for nonjudging, .88 for describing, .93 for nonreactivity, and .96 for the total scale, indicating excellent reliability. The CFA fit indices for the FFMQ in this study were GFI = 0.91, NFI = 0.94, CFI = 0.97, and RMSEA = 0.066, confirming the construct validity of the questionnaire.

Lifelong learning was measured using the 14-item Lifelong Learning Scale (LLS) developed by Kirby, Knapper, Lamon, and Egnatoff (2010). This instrument assesses five core factors: goal setting, use of knowledge and skills, self-direction and self-assessment, information location, and adaptation of learning strategies. Items are rated on a 5-point Likert scale ranging from "strongly disagree" (score 1) to "strongly agree" (score 5), with items 1, 2, 4, 6, 11, and 14 reverse-scored. Kirby et al. (2010) reported a Cronbach's alpha of .71, indicating acceptable reliability. In Iran, the scale was validated by Giahchi et al. (2019) using exploratory factor analysis and the principal component method. The analysis revealed a two-factor structure comprising "self-direction and self-assessment" and "use of knowledge and skills." Internal consistency coefficients for these factors were .47 and .63, respectively. In a two-week test–retest reliability study, coefficients of .81 and .70 were obtained, demonstrating satisfactory reliability. Divergent validity analysis indicated a negative correlation of −.46 between lifelong learning and academic burnout, while convergent validity was confirmed by positive correlations with deep learning (.52) and achievement motivation (.49). These findings suggest that the LLS possesses strong construct validity and can be effectively applied in both research and clinical contexts. In the present study, the Cronbach's alpha for the scale was .93, indicating high reliability. The CFA fit indices were GFI = 0.94, NFI = 0.97, CFI = 0.98, and RMSEA = 0.056, confirming the validity of the instrument.

Data Analysis

Data were analyzed using Structural Equation Modeling (SEM) with AMOS software to examine the hypothesized relationships among grit, mindfulness, and lifelong learning. Prior to analysis, data were screened for normality using skewness and kurtosis indices, and all variables met the assumption of normal distribution. Descriptive statistics (mean, standard deviation) and Pearson correlation coefficients were computed to assess variable associations. The reliability and validity of measurement instruments were verified through Cronbach's alpha and confirmatory factor analysis (CFA). Model fit was evaluated using multiple indices, including the Chi-square to degrees of freedom ratio (χ^2/df), Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Comparative Fit Index (CFI), Normed Fit Index (NFI), and Root

Mean Square Error of Approximation (RMSEA). Direct and indirect effects were tested, and significance was determined using standardized path coefficients and t-values at the 0.01 level.

Findings and Results

Table 1 presents the descriptive statistics of the study variables, including mean, standard deviation, skewness, and kurtosis. One of the assumptions of using a causal modeling approach is the normal distribution of variables. To examine the normality of the variables, skewness and kurtosis values were calculated.

Table 1. Descriptive Statistics of the Study Variables

Variables	Mean	Standard Deviation	Skewness	Kurtosis
Grit	38.51	9.04	-0.535	0.264
Mindfulness	113.52	26.05	-0.173	0.362
Lifelong Learning	38.61	12.07	-0.072	-0.453

As shown in Table 1, the absolute values of skewness and kurtosis for all variables are less than 1. Therefore, the assumption of normality in causal modeling is met. Table 2 reports the correlation matrix of the study variables.

Table 2. Correlation Matrix of the Study Variables

Variables	Grit	Mindfulness	Lifelong Learning
Grit	1		
Mindfulness	0.54	1	
Lifelong Learning	0.56	0.59	1
p < .01			

As presented in Table 2, the correlation coefficient between grit and mindfulness (r = .54) and between grit and lifelong learning (r = .56) was positive and significant at the .01 level. Similarly, the correlation coefficient between mindfulness and lifelong learning (r = .59) was positive and significant at the .01 level. Figure 2 illustrates the tested model for the research hypotheses with standardized coefficients for each path.

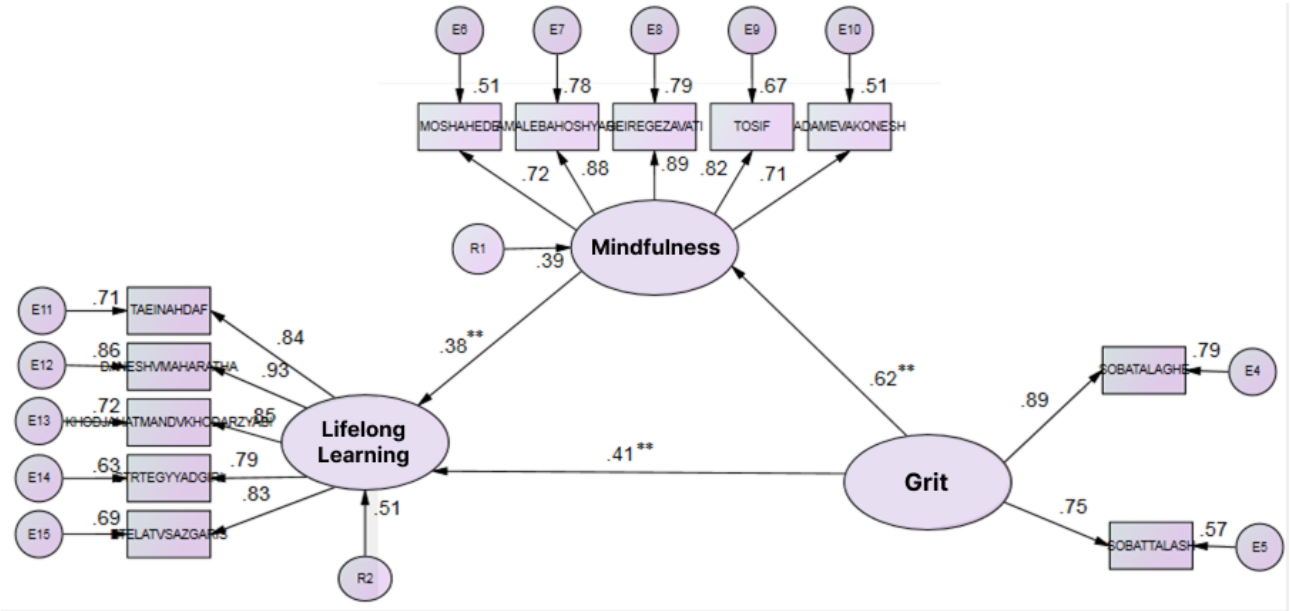

Figure 1. Tested Model of Lifelong Learning Based on Grit and the Mediating Role of Mindfulness

Table 3 reports the direct effects, t-statistics, and significance levels of the study variables.

Table 3. Results of Direct Effects in the Tested Model

Paths	Path Coefficient	t-statistic	Significance Level	Explained Variance
On Lifelong Learning:				0.51
Grit	0.41	7.405	.001	
Mindfulness	0.38	7.129	.001	
On Mindfulness:				0.39
Grit	0.62	10.835	.001	

As shown in Table 3, according to the path coefficient (β = .41) and the t-statistic (t = 7.405), grit has a positive and significant effect on lifelong learning. According to the path coefficient (β = .38) and the t-statistic (t = 7.129), mindfulness has a positive and significant effect on lifelong learning. Based on the path coefficient (β = .62) and the t-statistic (t = 10.835), grit has a positive and significant effect on mindfulness. According to the tested model and Table 3, 51% of the variance in lifelong learning and 39% of the variance in mindfulness were explained by the model variables. Another feature of structural equation modeling is examining the indirect effects of variables. Table 4 presents the results of indirect effects.

Table 4. Results of Indirect Effects in the Tested Model

Path	Path Coefficient	t-statistic	Significance Level
Mediating Role of Mindfulness in the Effect of:			
Grit on Lifelong Learning	0.24	5.955	.01

As shown in Table 4, according to the path coefficient (β = .24) and the t-statistic (t = 5.955), mindfulness plays a positive and significant mediating role in the relationship between grit and lifelong learning.

Table 5 presents the fit indices of the structural equation model, including the Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Comparative Fit Index (CFI), Normed Fit Index (NFI), Chi-square to degrees of freedom ratio (χ^2/df), and the Root Mean Square Error of Approximation (RMSEA).

Table 5. Goodness-of-Fit Indices for the Tested Structural Equation Model

Fit Index	Estimated Value	Acceptance Criterion
χ^2/df	2.97	< 5
RMSEA	0.061	< 0.08
GFI	0.937	> 0.90
AGFI	0.915	> 0.90
CFI	0.956	> 0.90
NFI	0.936	> 0.90

As shown in Table 5, the obtained indices in this study meet the acceptable thresholds for all fit criteria. The results indicate that the model demonstrates an adequate and satisfactory fit to the data and that the empirical data align well with the proposed factor structure.

Discussion and Conclusion

The results of the present study revealed that grit had a significant and positive direct effect on both mindfulness and lifelong learning among middle-aged adults. Moreover, mindfulness exerted a significant positive direct effect on lifelong learning and also played a mediating role in the relationship between grit and lifelong learning. These findings provide empirical evidence for the structural model proposed in this research, supporting the view that mindfulness serves as a key psychological mechanism linking

perseverance and passion for long-term goals with the ongoing pursuit of knowledge and skill development across the lifespan.

The observed direct relationship between grit and lifelong learning aligns with the theoretical framework originally proposed by Duckworth and colleagues, who conceptualized grit as perseverance and passion toward long-term goals, functioning independently of cognitive ability (11, 15). The finding that grit positively predicts lifelong learning is consistent with studies emphasizing that individuals high in grit are more likely to maintain effort and commitment to learning objectives even in the face of setbacks or competing demands (9, 12). This perseverance allows them to sustain self-directed learning behaviors and adapt to changing environments, which are hallmarks of lifelong learning (6).

Middle-aged adults often experience unique challenges such as occupational instability, family responsibilities, and cognitive aging, which may hinder continuous learning. However, individuals with higher levels of grit exhibit stronger self-regulation and motivation to overcome these barriers (4, 23). Grit not only enhances task persistence but also fosters long-term goal orientation, which is essential for lifelong educational engagement. Fowler (2025) found that grit and mindset were critical predictors of persistence among professional trainees, illustrating how perseverance enables sustained performance and learning even under pressure (16). Similarly, Fernández Martín et al. (2020) emphasized that grit acts both as a predictor and outcome of educational success, creating a reinforcing cycle between effort, achievement, and learning (20).

Furthermore, the present findings confirm the strong and positive association between mindfulness and lifelong learning. This result is consistent with Baer et al.'s (2006) conceptualization of mindfulness as a multifaceted construct involving observing, describing, acting with awareness, and nonjudgmental acceptance, all of which enhance learning engagement and metacognitive regulation (13). In this study, mindfulness was found to significantly predict lifelong learning, suggesting that learners who are more attentive to the present moment and less reactive to internal distractions can sustain focus and motivation throughout their learning journey. Prior studies have similarly demonstrated that mindfulness enhances learning quality, self-reflection, and the ability to integrate new knowledge effectively (19, 26).

Mindfulness appears to play a crucial role in enabling middle-aged learners to manage cognitive and emotional stressors associated with continuous education. Fu et al. (2024) found that mindfulness meditation significantly reduced depressive symptoms and improved emotional stability during stressful periods, thereby increasing cognitive openness to learning (27). Cheung and Djekou (2024) further demonstrated that mindfulness not only decreases mind wandering but also strengthens grit and self-compassion, suggesting a direct pathway through which mindfulness enhances perseverance and learning engagement (28). The current study's finding that mindfulness mediates the effect of grit on lifelong learning supports this interpretation—highlighting that perseverance alone may be insufficient without the cognitive and emotional balance that mindfulness provides.

The mediating effect of mindfulness in this model underscores its role as a self-regulatory mechanism that transforms effortful persistence into adaptive learning outcomes. Grit enables sustained goal pursuit, but mindfulness ensures that this pursuit is aligned with moment-to-moment awareness and emotional clarity (14, 25). This interaction between grit and mindfulness helps learners maintain both direction and flexibility—a combination that is especially critical for lifelong learning, which demands resilience as well as

adaptability (40, 41). Empirical support for this relationship has been provided by He et al. (2023), who found that teachers with higher grit and mindfulness reported greater well-being and job satisfaction (32). These findings parallel the present study by suggesting that mindfulness enriches the motivational structure established by grit, enhancing not only achievement but also psychological flourishing.

From a theoretical perspective, these results can be interpreted through self-discrepancy theory, which posits that the gap between one's actual and ideal self drives motivation and emotional experiences (37, 38). Lifelong learning often arises from a perceived discrepancy between one's current skills and desired competencies. Mindfulness, by fostering acceptance and nonjudgmental awareness, helps individuals acknowledge these discrepancies without self-criticism, thereby channeling motivation into constructive learning rather than avoidance (36). Meanwhile, grit allows individuals to persist through the discomfort associated with closing these self-gaps, sustaining effort until the desired goal is achieved (17, 39).

The study's findings also reinforce the importance of mindfulness as a cognitive and affective resource for self-regulated learning. Consistent with Issac et al. (2024), mindfulness facilitates "empowering knowledge" by enhancing reflection, self-awareness, and knowledge transfer (30). It encourages learners to remain open to new experiences, accept uncertainty, and adapt learning strategies accordingly (31). In combination with grit, mindfulness cultivates a form of psychological resilience that allows individuals to persevere through learning challenges with composure and focus. As noted by Daniel et al. (2024), mindfulness is also linked to spiritual well-being and sustainable behavior, suggesting that its influence extends beyond cognitive processes into broader dimensions of personal development (10).

The mediating role of mindfulness identified in this study echoes earlier empirical findings that mindfulness enhances motivation, emotional regulation, and persistence (22, 29). For example, Hwang and Nam (2021) highlighted that mindfulness-based interventions can strengthen grit by promoting attentional control and metacognitive awareness, which, in turn, facilitate consistent goal pursuit (22). This mechanism explains why mindfulness was found to mediate the effect of grit on lifelong learning—gritty individuals are more likely to succeed in their learning endeavors when they possess the attentional stability and emotional equanimity cultivated by mindfulness.

The high explanatory power of the model—accounting for 51% of the variance in lifelong learning and 39% in mindfulness—indicates that these constructs are interrelated components of a broader psychological system supporting lifelong education. This aligns with Schimschal et al. (2022), who conceptualized grit as part of a network of psychological resources that help individuals sustain goal-oriented behavior under uncertainty (21). Similarly, Fernández Martín et al. (2020) proposed that grit and mindfulness collectively contribute to success across educational, professional, and personal domains by reinforcing adaptive self-regulation.

The findings of the current study also align with those of Crick (2014), who viewed learning as a dynamic process influenced by motivation, identity, and systemic complexity (42). The interplay between grit and mindfulness represents an adaptive system of persistence and awareness that enables learners to maintain equilibrium while pursuing continuous improvement. The study further confirms the argument of Fang and Sim (2024) that lifelong learning enhances subjective well-being, especially among older adults (7). Thus, the model proposed here not only has psychological relevance but also social implications for promoting cognitive vitality and emotional health across the lifespan.

Moreover, the results support global educational perspectives that emphasize lifelong learning as an essential skill for sustainable development (1, 2). The combination of grit and mindfulness can be considered a psychological foundation for fostering such a learning culture. Lifelong learning requires not only persistence but also reflective awareness of one's cognitive and emotional processes. This dual competence allows individuals to engage more effectively with complex learning environments and adapt to evolving societal needs (5).

The connection between mindfulness, grit, and learning also highlights the potential of educational interventions that integrate cognitive-behavioral and contemplative training. Mindfulness-based education, as noted by Schuman-Olivier et al. (2020), can facilitate behavior change by increasing awareness of thought patterns and fostering intentional action (26). When coupled with grit training programs aimed at enhancing perseverance and goal setting (9, 22), such interventions may offer synergistic benefits for adult learners. The present study adds to this growing body of evidence by empirically validating the mediating mechanism through which mindfulness enhances the positive impact of grit on lifelong learning.

Overall, the findings confirm that grit and mindfulness function as interdependent psychological resources that promote lifelong learning in middle adulthood. Grit provides the motivational drive, while mindfulness offers the cognitive and emotional regulation necessary to sustain that drive over time. Together, they enable individuals to transform learning from a reactive response to external demands into a proactive, self-determined, and fulfilling endeavor.

Despite its contributions, this study has several limitations that should be acknowledged. First, the research design was cross-sectional, which limits the ability to infer causality between grit, mindfulness, and lifelong learning. Longitudinal studies would be more appropriate for exploring how these relationships evolve over time. Second, all data were collected through self-report questionnaires, which may be subject to social desirability bias and self-perception inaccuracies. Third, the sample consisted of middle-aged employees from a single urban region, which restricts the generalizability of findings to other age groups or cultural contexts. Finally, potential confounding factors such as personality traits, job satisfaction, or cognitive functioning were not included in the model, which might have influenced the observed relationships.

Future research should adopt longitudinal and experimental designs to examine causal pathways between grit, mindfulness, and lifelong learning. Incorporating objective behavioral measures or neurocognitive assessments could yield more comprehensive insights into how mindfulness practices influence learning persistence. Comparative studies across different age groups and occupational sectors could also clarify whether the observed relationships hold universally or vary by demographic factors. Moreover, qualitative approaches such as interviews or phenomenological analyses could enrich understanding of the lived experiences of adult learners. Researchers might also explore the potential moderating roles of contextual variables such as organizational culture, emotional intelligence, or digital learning environments.

Practitioners and educators can draw on these findings to design interventions that simultaneously cultivate grit and mindfulness among adult learners. Mindfulness-based training programs can be integrated into workplace learning and continuing education to enhance attention, stress management, and self-reflection. Similarly, goal-setting and perseverance workshops could strengthen individuals' grit and commitment to personal development. Educational institutions and organizations should foster

environments that value reflective learning, patience, and resilience. By combining mindfulness and perseverance-focused strategies, training programs can empower adults to engage more deeply in lifelong learning and adapt successfully to the evolving demands of modern life.

Acknowledgments

The authors express their deep gratitude to all participants who contributed to this study.

Authors' Contributions

All authors equally contributed to this study.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

Funding

This research was carried out independently with personal funding and without the financial support of any governmental or private institution or organization.

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