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Evaluation The Model Fit of Physical Exercise and Resilience: The Mediation Role of Mindfulness

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A B S T R A C T

Objective: This study aimed to investigate the mediating role of mindfulness in the relationship between physical exercise and resilience among sport science students.

Methods and Materials: A cross-sectional, quantitative design was used to explore the structural relationships among physical exercise, mindfulness, and resilience. The study involved 167 university students (86 males, 87 females; M_age = 20.17, SD = 1.05) from the Faculty of Sport Sciences and Health at the University of Tehran, selected through convenience sampling. Data were collected using three instruments: the Connor-Davidson Resilience Scale (CD-RISC), the Mindfulness Inventory for Sport (MIS), and a self-reported physical activity questionnaire calculating monthly exercise hours. Descriptive statistics were analyzed using SPSS 29, and structural equation modeling (SEM) was conducted in AMOS to assess the model fit and test the hypothesized mediational pathway.

Findings: The SEM analysis supported the hypothesized model, indicating satisfactory fit indices ($\chi^2 = 1.85$, df = 31, RMSEA = 0.05, CFI = 0.99, GFI = 0.99). Significant positive associations were found between physical exercise and resilience subcomponents, including personal competence ($r = .40$, $p < .01$), tolerance to negative affect ($r = .20$, $p < .05$), acceptance of change ($r = .43$, $p < .01$), and self-control ($r = .46$, $p < .01$), but not with spiritual influences. Physical exercise was also significantly correlated with mindfulness subcomponents such as awareness ($r = .32$, $p < .05$) and reconcentration ($r = .28$, $p < .05$), but not with being non-judgmental. Mindfulness significantly mediated the relationship between physical exercise and resilience ($\beta = .31$, $p < .01$), confirming its intermediary role.

Conclusion: The findings demonstrate that mindfulness plays a significant mediating role in the positive effect of physical exercise on resilience in sport science students. These results underscore the importance of integrated interventions combining physical activity and mindfulness to enhance psychological resilience and overall well-being.

Keywords: *physical exercise, mindfulness, resilience*

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1. Introduction

Physical exercise and resilience are two significant factors related to well-being (1). The concept of resilience can be trained (2) and cultivated via practices (3) to promote mental health (4) and physical health (5-7). From this perspective, resilience has been defined as the potential of objects to stretch and return to the main shape or the ability to adapt rapidly from difficulties, pressures, and stress (8). This concept came from physics to psychology and has been correlated with the character strength (9) that would lead to flourishing (10) and well-being (11). Resilience contributes to a) the personal insight of people to engage the world, b) the quality and quantity of social supports, and c) knowing and learning coping strategies (12-14). The debate about whether resilience is a process or a result of mental strength or thinking skills continues, likely because resilience is a complex idea linked to many factors, such as hardiness (15), optimism (16), relationships (17), self-care (18) , hope (19), productivity (20), creativity (21), and mindfulness (22).

Regular exercise and spontaneous physical activity improve resilience by offering important mental and physical benefits, reducing stress reactions, and guarding against harmful behaviors and metabolic issues that can lead to different chronic diseases (23-25). Sinha, Lacadie (26) found that resilient people show more activity in the left prefrontal cortex and anterior cingulate cortex (ACC), with more blood flow in the ACC during stress and when returning to normal. According to research, physical exercise activates the ACC (27), which is responsible for reasoning and decision-making (28). Exercise can improve how our body reacts to stress by making the hormonal systems, like the hypothalamic-pituitary-adrenal axis and the sympathetic nervous system, work better, which helps reduce emotional, physical, and metabolic responses to stress and boosts resilience (5, 29). Another potential mechanism by which physical exercise may enhance resilience is by the reduction of inflammation (30). Regular physical activity reduces excessive inflammation linked to prolonged psychological stress and physical inactivity. This anti-inflammatory action enhances behavioral and metabolic resilience (5). It also has been mentioned that physical exercise contributes to neural plasticity (31), which promotes resilience and well-being (32).

Mindfulness is a versatile and beneficial practice that promotes mental and physical well-being through present moment awareness and non-judgmental observation. Its integration into various therapeutic and educational settings highlights its broad applicability and effectiveness (33-35). The cingulate cortex has been reported to be active during meditation and states of mindfulness (36). Research indicates that both training (37, 38) and engagement in activities like physical exercise may boost mindfulness (39-41). It seems that pillars of mindfulness like being non-judgmental (42), being patient (43), trust (44), and acceptance (45) can boost when people are engaging with physical exercise and activities, and people who are engaging with physical exercise in their daily routine experience the state of mindfulness (46). Sports such as shooting (47) and dart throwing promote awareness by activating the systems of attention and concentration (48, 49), helping individuals to be present in the moment. Through mindfulness, neural activity increased in the right posterior cingulate cortex (50). These ideas supported the claim that experiencing mindfulness could lead to positive outcomes like resilience and well-being (51). Research indicated that mindfulness techniques can help athletes perform better during races and competitions. Herein, the main idea is that mindfulness could improve important mental skills for competing, like managing excitement, focusing attention, and pushing through challenges. Regulating arousal and attention are directly relevant to managing the pressure and demands during competition. Volitional skills, supported by mindfulness, help athletes overcome inner resistance like pain and fatigue during intense efforts (52).

The literature review reveals a deficiency in studies investigating the simultaneous interaction among physical exercise, resilience, and the mediating function of mindfulness, with the basic mechanisms of mindfulness's mediation in this setting remaining little examined. Engaging in physical exercise is anticipated to directly foster resilience and, through the cultivation of self-awareness and mindfulness during the activity, augment the capacity to adapt to stressful situations, thereby contributing to resilience. The primary objective of this study is to examine the model fit between physical activity and resilience, with mindfulness serving as a mediating variable. This study may provide a thorough grasp of how mindfulness improves resilience through physical exercise engagement. This approach can guide interventions and methods designed to enhance resilience through a blend of physical exercise and mindfulness practices. This study's findings can enhance the existing literature on the significance of incorporating mind-body techniques in fostering well-being (53) and resilience.

2. Methods and Materials

2.1 Study Design and Participants

This investigation was a quantitative cross-sectional analysis. Utilizing G*Power software version 3.1, a total of 173 students from the Faculty of Sport Sciences and Health at the University of Tehran were recruited through convenience sampling (male = 86, female = 87; mean age = 20.17, SD = 1.05). From this total, six subjects were removed from our analysis due to incomplete responses to the questionnaires. They participated in this study by completing three questionnaires detailed in the subsequent section (see Measures). Participants have identified their sport in four categories: football = 63, volleyball = 57, swimming = 39, and other sporting fields = 8.

The code of ethics for this study has been approved by the University of Tehran, Faculty of Education and Psychology. Each participant signed consent forms to take part in this research. They filled out two questionnaires: the Scale of Resilience (54) and the Mindfulness Inventory for Sport (55). It should be mentioned that questions including demographic information (age, sex, field of sport, and "the number of hours per day, the number of days per week, and the number of weeks per month") have been asked to investigate the amount of participants' engagement with physical exercise by self-administered questionnaire. The total score of physical exercise of participants was calculated (hours of physical exercise per day × number of days per week × number of weeks per month). The participants' minimum and maximum hours of physical exercise per month ranged from 29 to 52. After collecting the data, we used SPSS 29 to analyze descriptive statistics and employed AMOS software to evaluate the model.

2.2 Data Collection

Connor and Davidson (2003) Scale of Resilience: Connor and Davidson (54) developed this questionnaire comprising 25 states. The scores will be assessed using a Likert scale ranging from 0 to 4. The scoring range will be from 0 to 100. From this viewpoint, a higher score indicates increased robustness in the sample. Gonzalez, Moore (56) have documented the validity and reliability of this questionnaire. This scale identifies five primary characteristics of resilience: a) personal competency, b) tolerance of negative affect, c) acceptance of change and stable relationships, d) control, and e) spiritual influences. An Iranian study documented the alpha coefficients for the overall score of this scale and its subscales as 0.94 (57).

Mindfulness Inventory for Sport (MIS): Thienot, Jackson (55) established the inventory in three stages and specifically structured it for a sport and exercise environment. This study utilized the Persian version of MIS. The inventory encompassed 15 states, categorized into three primary subscales of awareness: non-judgmental behavior and reconcentration. An Iranian study reported the Cronbach alpha for this inventory as 0.79 for awareness, 0.86 for being non-judgmental, and 0.83 for reconcentration (58).

2.3 Data Analysis

For statistical analysis, descriptive statistics, including mean and standard deviation, were used alongside inferential statistics, including ANOVA, Shapiro-Wilk test, Levene's test, and covariance analysis. All statistical analyses were performed at a significance level of 0.05 using SPSS software version 23.

3. Results

The variables' means, standard deviations, and correlations were calculated (see Tables 1 and 2).

Table 1. Descriptive statistics of variables

	Variables	Mean	SD
Physical Exercise	Hours in month	1.60	2.10
Resilience	Personal competence	20.61	5.96
	Tolerance to negative affect	17.87	4.06
	Acceptance to change	12.94	3.75
	Self-Control	9.45	2.88
	Spiritual influences	4.93	2.28
Mindfulness	Awareness	16.22	4.65
	Re-concentration	13.20	4.71
	Being nonjudgmental	9.29	6.38

Table 1 illustrates that the average monthly physical exercise duration of our participants was 48 hours over 30 days (M = 1.60, SD = 2.10). The personal competency subfactor had the highest mean (M = 20.61, SD = 5.96), while the spiritual influences subfactor displayed the lowest mean (M = 4.93, SD = 2.28). Within mindfulness, the awareness subfactor exhibited the greatest mean (M = 16.22, SD = 4.65), while the non-judgmental subfactor recorded the lowest scores (M = 9.29, SD = 6.38).

Table 2. Correlations between variables

Variable	Physical exercise	Personal competence	Tolerance to negative affect	Acceptance to change	Control	Spiritual	Awareness	Re-concentration	Being nonjudgmental
Physical exercise	1								
Personal competence	.40**	1							
Tolerance to negative affect	.20*	.60**	1						
Acceptance to change	.43**	.68**	.61**	1					
Control	.46**	.73**	.65**	.67**	1				
Spiritual	.11	.50*	.35*	.14	.20*	1			
Awareness	.32*	.31*	.53**	.61**	.38*	.22*	1		
Re-concentration	.28*	.29*	.30*	.46**	.47**	.23*	.67**	1	
Being nonjudgmental	.16	.31*	.28*	.16	.12	.38**	.63**	.61*	1

*p<0.05, **p<0.01

We have used Structural Equation Modeling (SEM) with AMOS software to evaluate the main hypothesis of this study. The latent variables of physical exercise, mindfulness, and resilience have been utilized. The hypothesized model depicted in Figure 1 has been evaluated to assess its goodness of fit. The results also indicate that the criterion of $\chi^2 = 1.85$, df = 31, RMSEA = 0.05, SRMR = 0.005, CFI = 0.99, and GFI = 0.99 demonstrates a sufficient goodness of fit.

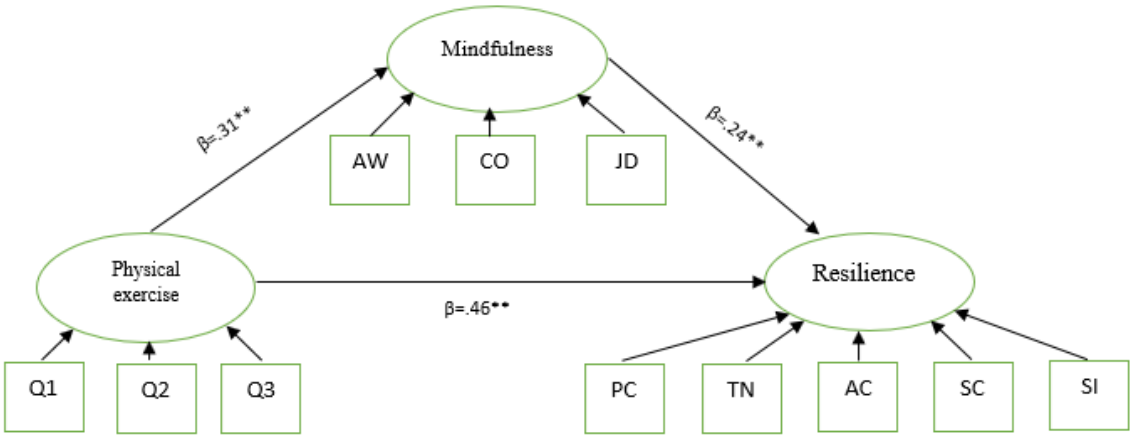

Figure 1. Model with Beta Values

Note: abbreviation of observed variables: AW=awareness, CO= concentration, JD= being non-judgmental, PC= personal competence, TN= tolerance to negative affect, AC= acceptance to change, SC = self-control, SI= spiritual influences.

4. Discussion and Conclusion

This study investigated how mindfulness might mediate the relationship between resilience and physical activity among university students. Our results confirm the suggested model by demonstrating a positive correlation between resilience and physical activity, whereby mindfulness serves as a mediator in this link. Clarifying the idea that mindfulness is applied will help to build a more accurate theoretical underpinning for these results. One can understand mindfulness in many different ways and at numerous levels. The literature suggests a hierarchical model separating contextual, situational (momentary) mindfulness, trait (global), and situational awareness. Like trait mindfulness, global mindfulness describes a widespread disposition toward awareness across many environments and temporal events. Contextual mindfulness is the habitual degree of attention a person pays in a given living setting, say in relation to physical exercise. Situational awareness is the degree of attention reached at a certain moment during a specific task (59). Designed especially for a sports and exercise setting, this study used the Mindfulness Inventory for Sport (MIS). The hierarchical perspective holds that the MIS evaluates contextual mindfulness, namely the standard mindfulness experienced during sports or exercise. By emphasizing contextual mindfulness—separate from global trait mindfulness or transient situational awareness—our work improves understanding of mindfulness. Regarding state mindfulness—including its contextual variants—research on it has been underrepresented in the body of knowledge on physical exercise. Analyzing contextual mindfulness is crucial since it provides a possibly modifiable goal for behavioral treatments meant to improve physical exercise experiences.

The research findings indicated that the average duration of physical exercise among participants was four hours daily, four days weekly, and three weeks monthly. These results are logical, as the study participants were sport science students who engage in exercise more frequently than other university demographics. We recommend assessing the model's fitness for replication across diverse populations. b) Robust correlations existed between physical exercise and resilience subfactors, such as personal competence, tolerance to negative affect, acceptance of change, and self-control; however, no association was found with the subfactor of spiritual influences. Physical exercise, encompassing movement and practice, is associated with the aforementioned resilience subfactors (23). Participation in physical exercise as a constructive, goal-directed activity can forecast personal competence, adaptability to change, and self-regulation (60-62). Physical exercise is known to improve the perception of personal competence, especially when individuals define it through both internal and extrinsic goal-setting (63). According to Self-Determination Theory (SDT), setting personal goals for oneself is expected to lead to a stronger desire for competence than goals set by outside factors, which is linked to being resilient, feeling good, and thriving (64). Furthermore, the enhancement of self-efficacy and confidence fosters resilience (65). Likewise, physical exercise enhances the perception of self-regulation over the body and surroundings, thereby augmenting the capacity to manage stress (66). The acceptance of change, an element of resilience, is associated with the concept of mindfulness as anticipated by physical activity (67).

This study's findings revealed a significant association between physical exercise and mindfulness among participants. While no significant link was seen between the nonjudgmental subfactor and physical activity, the results aligned with the research conducted by Schneider, Malinowski (39) and Ludyga, Gerber (68). During physical activity, individuals engage multiple physiological sensations, which are crucial for perceiving the present moment. This finding can be explained by understanding that physical exercise, as described here, is a planned movement of the body that includes thinking (like making decisions or solving problems), feelings (such as joy, happiness, or hope), and awareness (like paying attention and being focused). Such activity is perceived as a positive behavior conducive to mental health (69), with our focus being on the factor of "resilience."

The most important finding of this study was that the suggested model fits the data. According to the findings of SEM, mindfulness plays a role as the mediator between physical exercise and resilience. It should be noted that the model can be explained from a neuroscience perspective, looking at the action of the ACC in the brain (70). We know that the anterior cingulate cortex is a region in the brain that is responsible for different cognitive functions like reasoning, decision-making, attention, and emotion regulation (71). According to the study of Voss, Heo (72), during physical exercise, specifically aerobic exercise, gray matter volume in the ACC has been increased significantly. While the association between ACC, physical exercise, mindfulness, and resilience is multifaceted and complicated, the goodness of fit of our model can be applied by other

researchers to study the mechanism both psychologically and physiologically in this process in different populations. Although there is a limitation that we encountered during this study, and that is the convenience sampling method from the population of sport science students. We suggest that for further research, this model be studied in different populations, particularly in those who are not athletes. On the other hand, it is of value to check the fitness of the model in elite athletes.

The key result of this investigation was that the proposed model aligns with the data. SEM findings indicate that mindfulness serves as a mediator between physical activity and resilience. The model can be elucidated from a neuroscience standpoint by examining the function of the ACC in the brain (70). The anterior cingulate cortex is a brain area implicated in various cognitive tasks, including thinking, decision-making, attention, and emotional control (71). The research conducted by Voss, Heo (72) indicated that aerobic exercise dramatically enhances gray matter volume in the anterior cingulate cortex (ACC). The interplay of the ACC, physical activity, mindfulness, and resilience is intricate; nonetheless, our model can assist other researchers in examining how these elements interact both mentally and physically across diverse populations. This study encountered a limitation due to the employment of a convenience sample strategy among sport science students. Future research should examine this approach in other populations, especially non-athletes. Conversely, it is important to assess the model's efficacy in elite athletes.

This study's principal finding is that physical exercise enhances resilience in sport science students through the mediation of mindfulness. The proposed model, which asserts that mindfulness mediates the relationship between physical activity and resilience, exhibited satisfactory goodness of fit with the data. The findings suggest that engaging in physical exercise can boost resilience, and the development of mindfulness during the exercise influences this relationship. This work fills a gap in the literature by concurrently examining the interplay between physical exercise, mindfulness, and resilience, and it elucidates the processes via which mindfulness may bolster resilience through physical exercise. The results offer observations about the interaction of these components on both mental and bodily levels. The results indicate that therapies combining exercise and mindfulness approaches may effectively enhance resilience and promote well-being. This methodology can inform the creation of strategies aimed at augmenting resilience using a combination of physical activity and mindfulness techniques.

This study encountered a limitation due to the employment of a convenience sample strategy among sport science students. Future research should examine this approach in other populations, especially non-athletes. Conversely, it is important to assess the model's efficacy in elite athletes. A further limitation of our study was the diverse range of sports among participants, encompassing activities from football to dart drawing. It has been proposed to evaluate the model inside a particular sport to see which discipline may yield a greater degree of mindfulness and elicit heightened activation of the anterior cingulate cortex in the brain. An additional recommendation for research involves assessing model fitness in team sports (such as football) or individual activities (such as darts or shooting). This study aims to address the existing research gap and provide insights into the mechanisms by which mindfulness improves resilience outcomes. The results have practical implications for developing successful therapies and programs that enhance resilience by incorporating exercise and mindfulness techniques.

Authors' Contributions

All authors equally contributed to this study.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

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

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