



THE EFFECT OF NEUROCOGNITIVE SKILLS TRAINING BASED ON THE EFFICIENCY OF MINDFULNESS VARIABLES ON BEHAVIORAL, COGNITIVE AND SPORTS EMOTION AMONG ADOLESCENT ATHLETES AGED 10 TO 17

(Research article)

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Abstract

This study was conducted to investigate the effect of training in neurocognitive skills based on the efficiency of mindfulness variables on behavioral, cognitive, and sports emotion among adolescent athletes aged 10 to 17. A quasi-experimental study was conducted with a pre-test and post-test design with a control group. The statistical population of the study was all adolescent athletes aged 10 to 17 in Tehran, and 30 eligible subjects voluntarily entered the study using a purposive sampling method. Then, they were randomly divided into two groups of 15: experimental and control. The experimental group received neurocognitive skills based on mindfulness, and no intervention was performed for the control group. The Sports Emotion Questionnaire (Jones et al., 2005), the Sports Self-Confidence Resources Questionnaire (Willie et al., 1998), and the Perceived Physical Fitness Questionnaire (Abadi, 1998) were used to collect data. Data analysis was performed using univariate analysis of covariance using SPSS statistical software. The significance level for all tests was set at 0.001. The results of the analysis of covariance showed that mindfulness-based neurocognitive skills training in the post-test significantly increased the mean scores of the behavioral efficiency subscales ($p=0.001$), cognitive efficiency ($p=0.001$), and sports emotion efficiency ($p<0.001$) in the experimental group compared to the control group. According to the results of the study, we conclude that mindfulness-based neurocognitive skills training improves behavioral and cognitive efficiency and sports emotion, and this training can be used as a suitable program to increase the efficiency of adolescent athletes aged 10 to 17 years in different sports situations.

Keywords: Neurocognitive skills, mindfulness, behavioral cognitive sports emotion, adolescent athletes.

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1. Introduction

In the field of sports, there has always been an effort to overcome physical limitations. Now, thanks to the evolution of this field, we know that other vital elements also affect the performance of athletes. Success in the world of sports is not determined solely by the physical capabilities of athletes. In order for an athlete to be able to perform well in stressful situations of sports competitions, he needs to manage attention and active memory and make timely decisions with minimal errors. Strong memory and the capacity to learn from mistakes are other cognitive abilities required by a professional athlete. (Hemayat Talab et al., 2016) Sports are a phenomenon of human society in recent centuries. Sports are a messenger of peace and friendship among all nations of the world and are one of the important factors of ethnic, racial and ideological proximity in the world. The development of human society is meaningless without the development of sports (Crivelli et al., 2019). Sports have become one of the important components of individual and social health (Josefsson et al., 2019). Sports competitions at the international level have become very close; Therefore, the use of modern methods aimed at improving behavioral efficiency, cognitive efficiency, and emotional efficiency has become particularly important in order to reduce the possible errors of athletes in difficult and exhausting conditions of competition, increase the attention and concentration of athletes, and maintain and improve sports performance (Zhu et al., 2022). Training of neurological skills based on mindfulness in the country's sports field is one of the urgent needs that should seriously attract the attention of officials, managers, coaches, and athletes. The results of the study by Hamat Talab and colleagues indicated that mental exercises improve athletes' performance (Su, 2020; Serin and Okludil 2020). Various studies have examined the effect of cognitive exercises on athletes' performance. For example, some studies show that brain stimulation can be one of the ways to improve athletes' skills. The effect of this method has been seen more in sports such as basketball or volleyball, which require coordination of visual perception and execution of targeted movements. Another study shows that cognitive-perceptual exercises have had an impact on the sports performance of basketball and football players. Virtual reality goggles have been able to improve the ability to inhibit, make decisions, and visually search in soccer players. Other studies have confirmed the effectiveness of mindfulness, imagery, and self-talk exercises on athletes' performance. Meanwhile, the effectiveness of different cognitive training methods is under debate. Some researchers believe that physical training, taking into account cognitive aspects (such as table tennis training) can play a role in improving players' cognitive performance more than laboratory cognitive tasks (such as Go/NoGo task) (Su et al., 2024). Such results emphasize the position that athletes' cognitive training should be closer and more consistent with real-world situations and their activity environment (Bondar et al., 2024). On the other hand, some researchers express concern that the advertising impact of such training has exceeded the available scientific evidence. From their point of view, we should distinguish between the two propositions that cognitive training improves players' cognitive abilities and that improving cognitive abilities necessarily improves athletes' performance in real-world situations. However, most research has neglected sports environments and has limited its interventions and evaluation criteria to laboratory settings (Moen et al., 2018). Competition and competition conditions sometimes cause athletes to react physically and mentally that negatively affect their abilities and performance. In these conditions, words such as stress and anxiety are used to describe the conditions of athletes. The problem occurs when you allow your mind to work against you instead of working for you. When you accept anxiety as part of the complications and conditions of competition, then anxiety can help you compete better. Sport naturally involves competition, which

is anxiety-provoking and increases arousal. Undoubtedly, most of the theories proposed in this field, such as neuromuscular psychomotor theory, symbolic learning theory, dual coding theory, bioinformatics theory, triple code theory, etc., support the role of mental training in improving desirable indicators in motor performance (Isbel et al., 2019). For this reason, today we can boldly admit that there is a close relationship between cognitive, emotional, and behavioral efficiency in sport and the development of athletes. In order to educate and develop athletes, special attention should be paid to all three aspects: behavioral, emotional, and cognitive. These three aspects actually form the conceptual framework of human personality, and neglecting any of them prevents a person from achieving their goals (Corrado et al., 2024). Mindfulness, as a psychological concept, emphasizes alert attention and focus, which is effective in reducing anxiety, depression, and stress. Mindful people perceive internal and external realities freely and without distortion and have a great ability to deal with a wide range of thoughts, emotions, and experiences, both pleasant and unpleasant (Gardner & Moore, 2019). Mindfulness is a skill that allows a person to perceive events in the present moment as less distressing than they are. Mindfulness helps us understand that negative emotions may occur, but they are not a fixed and permanent part of personality. It also allows the individual to respond to events with thought and reflection, rather than involuntarily and thoughtlessly. Increased mindfulness is associated with increased psychological well-being, agreement, openness, and reduced pain symptoms. In fact, mindful individuals are more capable of recognizing, managing, and solving everyday problems (Ross & Keiser, 2014). Research has shown that to improve sports performance, it is not necessary to eliminate, change, or control internal cognitive and emotional levels; rather, it is necessary to develop mindful thinking, accept and internalize the present moment (such as thoughts, emotions, and bodily sensations), clarify valuable goals, and increase attention to external cues, responses, and possibilities required for sports performance (Brito et al., 2022). Training learners in skills related to behavioral performance is done with the aim of reducing the time it takes to become a professional and, consequently, reducing the emotional burden caused by the time pressure. According to researchers, enhancing performance and motor skills in athletes, on a short time scale and with little effort, is a desirable goal in professional sports. In sports, three main indicators are defined for preparing athletes: physical fitness, mental fitness, and technical fitness. All three of these indicators are a combination of three cognitive, behavioral, and emotional components (Nien et al., 2024). Basic motor skills training in all sports has many things in common; for example, physical fitness and methods of coordinating the neuromuscular system are common ground among all sports disciplines. Behavior, in turn, is not an isolated component and is intertwined with other components such as sports emotional performance and sports cognitive performance. The formation of cognitive, behavioral, and emotional outcomes in motor skills is possible through educational mechanisms, and these outcomes are achieved through practice, rehearsal, and the systematic application of educational techniques and principles (Kaufman et al., 2019). This argument is based on numerous studies that have shown that mindfulness practice can positively affect both individuals' evaluation of stressful situations and their stress responses (Gardner & Moore, 2020). Various factors affect athletes' behavioral, cognitive, and emotional sports performance, including mindfulness training. Regular exercise training has been proven to provide positive results in terms of both health and performance (Serin and Taşkın 2016; Serin, 2019; Serin, 2020). Active elements in mindfulness meditation focus on increasing awareness of thoughts, feelings, and behavior. Sports mindfulness is derived from the third wave approach in psychology, which is a new discussion under the name of sports mindfulness (6). Mindfulness skills are known to be an important and effective factor in freeing individuals from automatic thoughts, habits, and unhealthy behavioral patterns (Teasdale et al., 1995). In addition, research has shown that higher levels of mindfulness are associated with higher levels of athletic success (Teasdale, 2006). Mindfulness training helps athletes focus on the

present moment and master their responsibilities to perform tasks with awareness and presence of mind. Presence of mind means that individuals shift their information, cognition, and awareness from the past and future to the present. When individuals are present, they see reality in all its internal and external contexts and realize that the mind is always engaged in self-delusion and internal dialogue due to the judgments, interpretations, and interpretations it has made. When individuals realize that the mind is always explaining, they will be able to pay close attention to their thoughts and understand the reason for their emergence. Practicing mindfulness allows a person to understand that “thoughts are just thoughts” and to better let go of thoughts when they become aware that they may not be true. One of the important principles of mindfulness is “letting go” (Holfelder et al., 2020). Coaches in the field of athletic training use mindfulness techniques to increase athletes’ focus and reduce their anxiety and stress levels. Increasing focus and managing emotions in the midst of high-pressure competitions improves athletes’ cognitive, behavioral, and emotional performance (Bigelow et al., 2021). Many sports psychologists have confirmed in recent years that mental and psychological skills are the most important factor in athletes’ success. Differences in mental preparedness and how to manage anxiety can make or break athletes at the highest levels (Mitsea et al., 2023). Researchers have concluded that injured athletes can benefit from using mindfulness as part of their rehabilitation process to increase their pain tolerance and awareness. Further research is needed to assess whether increasing pain tolerance helps with treatment (Sachs et al., 2017). Heckman has shown that adding mindfulness training to an athlete’s training program has many benefits. Developing athlete-specific mindfulness not only opens up new avenues for mindfulness training, but could also provide new theories about sports psychology (Heckman, 2018). Mozafari Zadeh et al. pointed out the significant implications of the effective relationship of a mindfulness and acceptance training program in reducing sports injury anxiety and improving the performance of soccer players and stated that sports coaches and sports psychologists can use mindfulness as a simple and inexpensive method to reduce sports injury anxiety and improve sports performance (Mozafari Zadeh et al., 2019). Sports science theorists attribute success in sports fields to a combination of physical and mental abilities, and most experts also believe that at least 50% of success in a tournament depends on the mental and psychological preparation of athletes on the day of the match (van de Water et al., 2017). No study was found that examined the effect of mindfulness-based neurological skills training for athletes and its effect on behavioral and cognitive performance variables and sports excitement, and the gap in studies in this field is evident; therefore, more coherent studies are needed in this area; Therefore, the present study aimed to investigate the effect of training neurological skills based on the efficiency of mindfulness variables on behavioral, cognitive, and sports emotion among adolescent athletes aged 10 to 17.

2. Method

The present study was a semi-experimental study with a pre-test and post-test with a control group. The statistical population consisted of all male adolescent athletes aged 10 to 17 years in Tehran in 1402. Since at least 15 people are recommended for each group in experimental methods (Zaal et al., 2020). In compliance with health protocols, thirty male adolescents who met the inclusion criteria for the study were voluntarily included in the study as a purposive sample. Then, they were randomly assigned to two groups of fifteen experimental and fifteen control individuals. The criteria for selecting clients were: having at least one year of experience in sports training; having no history of psychological treatments before the intervention, the subject's consent to participate in the study, and obtaining written consent. The study exclusion criteria included unwillingness to continue cooperation and missing more than one session of mindfulness-based neurological skills training sessions.

2.1. Data collection tools

Sports Self-Confidence Resources Questionnaire

The Sports Self-Confidence Resources Questionnaire, 1998, form 43, was used to measure cognitive efficiency and its components. Willy et al. designed and developed this questionnaire to assess the sources of self-confidence in athletes. The questionnaire has nine subscales and measures the sources of sports self-confidence based on a seven-point Likert scale (1 = completely disagree and 7 = completely agree). Willy et al. developed the Sports Self-Confidence Resources Questionnaire with the subscales of skill mastery (five items), physical/mental fitness (six items), coach leadership behavior (five items), social support (six items), physical self-expression (three items), ability demonstration (six items), environmental comfort (four items), alternative experience (five items), and desired situation (three items). In their study, Vealey et al. reported the content validity (CVI) of the questionnaire as 0.92 and the Cronbach's alpha coefficient for the subscales in the range of 72 to 87 percent (Vealey et al., 1998).

Sports Emotion Questionnaire

This questionnaire was developed by Jones et al. to assess the sports emotions of athletes during or before exercise and has 22 questions on a Likert scale. The questionnaire includes five pervasive emotions: anxiety (items 1, 6, 11, 16, 21), depression (items 2, 7, 12, 17, 22), excitement (items 3, 8, 13, 19), anger (items 4, 9, 14, 18) and happiness (items 5, 10, 15, 20), which are used on a five-point Likert scale (0 = never to 4 = very much). Its reliability in the questionnaire was obtained by Cronbach's alpha method from 0.81 to 0.88. Also, its construct validity was proven by using the correlation coefficient of the questionnaire with the emotion control subscale during sports competitions by testing performance strategies and also by confirmatory factor analysis method, and the fit indices (RMSEA=0.93, RCFI=0.070) were of appropriate suitability (Jones et al., 2005).

Perceived Physical Fitness Questionnaire

To measure behavioral efficiency and its components, Abadi's Perceived Physical Fitness Questionnaire, twelve-question form, was used. The questionnaire questions are based on a five-point Likert scale (completely agree to completely disagree) which is designed in five main sections of physical fitness including cardiorespiratory endurance, strength, muscular endurance, flexibility and body composition and in the revised form, it was converted into four sections (physical conditions, flexibility, muscular conditions, body composition). Each question is assessed with a five-point Likert scale. The total score of the individual is 60. In his study, Abadie reported the content validity index (CVI) of the questionnaire as 0.91 and the Cronbach's alpha coefficient for the subscales in the range of 76 to 88 percent (Abadie, 1988).

It should be noted that, in order to comply with the principle of ethics in research, the principle of confidentiality and confidentiality of the participants' information was observed. After determining the criteria for entering the study of the sample group and randomly counting the subjects in the two experimental and control groups, first, in both groups, the behavioral, cognitive, and emotional sports efficiency questionnaire was administered in compliance with health protocols. Then, the experimental group received mindfulness-based neurological skills training based on the Williams protocol (Segal et al., 2012). Subsequently, the questionnaires were administered again as a post-test in the two groups. No intervention was performed in the control group. In the present study, mindfulness-based neuropsychological skills training was conducted over eight weekly sessions of sixty minutes in compliance with health protocols. To examine the content validity of the sessions, 10 psychology professors with a PhD and at least an assistant professorship in the field of mindfulness and sports psychology were consulted, and the content was

qualitatively approved by the relevant professors. In the first session, the questionnaire was given to the experimental group as a pre-test and to the control group at the same time. A summary of the training sessions is shown in Table 1.

Table 1. Titles of mindfulness-based neurocognitive skills training sessions (Jalali et al., 2015)

Session	Content
First	Introduction, explanation of group principles, explanation of performance stress and its consequences, explanation of the concept of mindfulness with regard to the mystical concept of the presence of the heart, introduction and explanation of the qualities of mindfulness with regard to Islamic concepts and thought, brief introduction of the mindfulness model, metaphor of the shepherd's property
Second	Autopilot, heartlessness, doing-it-yourself and being-now mindset, raisin eating practice
Third	Conscious breathing, explaining the concept and value of the soul from the perspective of Islamic mysticism, the metaphor of two blessings in one soul
Fourth	Body Check Meditation Practice, the Importance of Being Kind and Honest with the Body from an Islamic Perspective
Fifth	Practicing the relationship between thoughts and emotional and behavioral reactions, the importance of healthy thinking in Islam and how to deal with ineffective thoughts, practicing sitting meditation.
Sixth	The relationship between workplace thoughts and emotional reactions and functional behavior (cognition-emotion relationship), the metaphor of futility of thoughts, the practice of walking awareness
Seventh	Explaining and comparing the concept of acceptance with respect to the concept of "reza" in Islamic thought, practicing awareness of voice and strategy, presenting the poem "Zangi"
Eighth	Attendance permit practice, flight attendant metaphor based on the guest house poem, using mindfulness in everyday life and the workplace, sense constable metaphor

Attendance permit practice, flight attendant metaphor based on the guest house poem, using mindfulness in everyday life and the workplace, sense constable metaphor.

3. Findings

Based on the results obtained, the mean and standard deviation of the age of the participants for the experimental group was 16.02 ± 0.12 and for the control group it was 15.16 ± 1.25 years. Table 2 presents the mean and standard deviation of the scores of the scales of emotional sports efficiency, cognitive efficiency and behavioral efficiency in the pre-test and post-test of the research groups. Based on the information in Table 2, the mean of the total index of emotional sports, behavioral and cognitive efficiency of the experimental group in the pre-test stage was 38.23 ± 2.12 , 6.24 ± 2.36 and 254.12 ± 2.22 respectively, which improved in the post-test stage and reached 31.22 ± 1.63 , 81.9 ± 2.67 and 292.17 ± 2.28 respectively. These changes were relatively significant compared to the average of the control group in the pre-test and post-test stages. It is observed that in all scales of emotional sports efficiency, behavioral efficiency and cognitive efficiency, the mean post-test scores of the experimental group improved compared to the pre-test; however, the mean post-test scores of the control group did not change significantly compared to the pre-test. In order to examine the inferential nature of the data, the analysis of covariance method was used. Before performing the analysis of covariance, the Shapiro-Wilk and Levine tests were used to observe its assumptions. The assumption of normality of the data in the post-test stage was not rejected for both the experimental and control groups; in other words, the data distribution was normal ($p < 0.001$). Based on the Levine test and its non-significance, the condition of equality of variances between groups was observed ($p < 0.001$). The non-significance of the beta of the post-test interaction of each variable and group in

the linear regression model indicated the homogeneity of the slopes of the regression lines ($p < 0.001$).

Table 2. Descriptive indices of emotional sports efficiency, cognitive efficiency, and behavioral efficiency in the pre-test and post-test, separated by experimental and control groups, along with the results of analysis of covariance with adjustment for the pre-test effect.

Variable	Group	Pre-test		Post-test		Comparison Post-test		
		Average	Standard deviation	Average	Standard deviation	f-value	P-value	Eta squared
Total Sport Emotional Efficiency	Test	38/23	2/12	31/22	1/63	16/12	$\leq 0/001$	0/812
	Certificate	42/33	1/15	41/21	0/23			
Behavioral Efficiency	Test	6/24	2/36	9/81	2/67	7/26	$\leq 0/001$	0/514
	Certificate	5/14	0/36	5/14	0/25			
Total cognitive efficiency	Test	245/12	22/25	292/17	2/28	8/15	$\leq 0/001$	0/724
	Certificate	246/36	22/36	245/12	15/24			

To examine the patterns of difference, analysis of covariance was used as described in Table 2. After removing the effect of the pre-test, a significant difference was found between the mean scores of the experimental and control groups in the post-test. Considering the significance levels of the F test, it was observed that the results of the covariance test for the scales of total sports emotional efficiency ($p < 0.001$), behavioral efficiency ($p = 0.001$), and total cognitive efficiency ($p = 0.001$) were significant; therefore, observing Table 3 shows that there is a significant difference between the two experimental and control groups in the total index of sports emotional efficiency, behavioral efficiency, and total cognitive efficiency. In other words, mindfulness-based neurocognitive skills training was able to improve these indicators. Also, the value of the eta squared indicated that the percentage of changes in the groups' scores in each variable was the difference between the groups in the post-test due to the implementation of the independent variable (mindfulness-based neurocognitive skills training). The largest effect size was related to the total emotional sports efficiency index scale (0/812) and the smallest effect size was related to the behavioral efficiency index (0/514).

4. Discussion

The aim of this study was to investigate the neuroscience of mindfulness-based sports performance on behavioral, cognitive, and emotional outcomes among male wrestlers. The results of the present study showed that the overall mean scores from the behavioral, cognitive, and emotional outcomes questionnaire before training were lower than the mean scores after training. Based on these findings, it can be concluded that mindfulness-based neuroscience skills training is effective on behavioral, cognitive, and emotional outcomes in sports, and the experimental group of athletes had significantly better scores than the control group in behavioral, cognitive, and emotional outcomes. The data revealed that the levels of behavioral performance in the pre-test phase in the two groups were almost similar; however, in the post-test phase, mindfulness increased in the experimental group compared to the control group. A review of research conducted since Kabat-Zinn until 2011 revealed eighteen empirical studies on mindfulness, fourteen of which showed that mindfulness-based approaches lead to athletic success and skilled performance in

college and non-college athletes in disciplines such as golf, track and field, archery, etc., and four other studies did not confirm anything (Kaufman et al., 2019, Namaki et al., 2022). In the study, mindfulness skills, psychological flexibility, and symptoms of mental disorder were compared among 50 less physically active and 50 physically active adults, based on their self-reported physical activity. In addition, this study examined the objective relationship between physical activity and psychological variables, supporting the view that adults with more physical activity have better mental health compared to adults with less activity. These results also showed that an active lifestyle is related to better mindfulness skills and fewer symptoms of mental disorder and depression (Ross & Keiser, 2014). In a case study in which a 21-year-old male golfer received a six-week mindfulness and relaxation intervention using meditation and training, progress was measured by increasing golf scores and written scores. In this study, golf scores and written scores showed significant improvements in performance during the mindfulness period. In addition, several studies have shown that higher levels of mindfulness are associated with higher levels of athletic success (Farsi & Zamani, 2014). There is preliminary evidence that mindfulness is a trait that enhances athletic performance (Heckman, 2018). Mindfulness improves athletic performance. This may be because mindfulness training reduces negative thoughts, anxiety, stress, and anger, while increasing athletic happiness and enjoyment of the sport. This suggests that barriers to improving athletic performance are reduced and, conversely, positive constructs that help enhance athletic performance are increased (Namaki et al., 2022). Obviously, in such circumstances, we should see an increase in athletes' performance. The scores of the nine cognitive performance components in the two mindfulness and control training groups were almost similar in the pre-test phase; however, in the post-test phase, the experimental group increased compared to the control group. Mindfulness training was effective on the nine cognitive performance components (skill mastery, ability enhancement, physical/mental fitness, physical self-expression, social support, coach leadership, alternative experiences, environmental comfort, and desired situation). Mindfulness training consistently and beneficially moderated sports self-confidence scores. In addition, physiological and psychological proxies improved significantly after mindfulness training, as well as performance outcomes in shooting and darts. It seems logical to consider mindfulness training strategies as a systematic approach to supplement mental skills training for athletes, at least in precision sports (Bühlmayer et al., 2017). Self-confidence is essential not only for the accurate execution of sports skills, but also for the development of basic motor skills among adolescents (McGrane et al., 2016, Namaki et al., 2022). Although Kabat-Zinn and colleagues were the first to implement mindfulness training in collegiate and Olympic athletes (Kabat-Zinn, 2012), a recent increase in published research using mindfulness to enhance sports performance has emerged. In addition, mindfulness interventions have been shown to reduce anxiety, increase self-confidence, increase enjoyment of participating in a particular sport, increase adherence to training regimens (Kabat-Zinn, 2012), reduce perceived stress (Holfelder et al., 2020), and reduce injury risk among athletes (Jones et al., 2005). These psychological skills are considered as a set of trainable psychological characteristics and are the necessary abilities to cope with sudden difficult situations that help them improve their performance. These psychological skills also contribute to the development of successful talents and optimal performance by elite athletes (Kabat-Zinn, 2012) and include the ability to cope, motivation and attention or self-confidence and stress regulation (Su et al., 2024; Teasdale, 2006; Teasdale et al., 1995; van de Water et al., 2017, Namaki et al., 2022). In addition, several studies have shown that successful athletes show greater motivation, self-confidence and focus compared to amateur or sub-elite athletes (Zaal et al., 2020). It has been shown that mindfulness training increases athletes' sports self-confidence (Zhu et al., 2022). The findings of the present study also confirmed this conclusion. Since sports self-confidence originates from sources, it is natural to assume that mindfulness training affects sports self-confidence through

sources of self-confidence. The findings of the present study showed that mindfulness training significantly increases the nine components of sports self-confidence sources, so it can be suggested that mindfulness training should be included in adolescent athlete training programs by coaches to increase athletes' self-confidence. This study suggests an independent study in this area. Data analysis showed that the levels of anxiety, depression, arousal, and anger in the mindfulness group were significantly reduced compared to the control group, and the level of happiness in the mindfulness group was significantly increased compared to the control group; therefore, it can be concluded that mindfulness training is effective in improving emotional performance in sports and reduces sports anxiety. Athletes generally become anxious for various reasons, including achieving athletic success, differences in their abilities, or the necessary capabilities to perform sports, and this anxiety interferes with their performance as a negative factor. Anxiety is a negative emotional state with feelings of anger, discomfort, and worry that are associated with physical arousal (Teasdale et al., 1995, Namaki et al., 2022). Anxiety in sports reflects the athlete's feelings based on the fact that something may go wrong and, as a result, lead to failure in performance. Cross-sectional designs have shown that mindfulness, as an indirect and inherent human characteristic, is associated with well-being in athlete populations (McGrane et al., 2016). Mindfulness is also inversely correlated with cognitive and physical anxiety. The fact that cognitive anxiety is a mediator of the observed relationship between mindfulness and perceived sports performance suggests that mindfulness may be beneficial for sports performance (Gardner & Moore, 2020). According to meta-analyses of mindfulness interventions, mindfulness interventions were effective in reducing anxiety and depression in clinical and non-clinical populations. Mindfulness interventions have also shown effectiveness in improving health, hedonic health, and happiness in a wide range of populations, such as teachers and others (Kaufman et al., 2019). Research findings have shown that mindfulness training is effective in reducing adolescent athleticism; however, there is conflicting research in this area, so research in this area needs to continue. There is evidence that mindfulness is associated with more benign responses to emotional stimuli, especially those of an unpleasant or threatening nature; for example, mindfulness is associated with cortical and limbic markers of emotional reactivity, including less activation of the amygdala at rest (Brito et al., 2022). Arousal is related to the widespread physiological and psychological activity of body systems that are important for regulating the behavioral outcomes of consciousness, information processing, and attention (Abadie, 1988). Early works such as the Bruton effect emphasized the need to examine the relationship between arousal and sleep. Other works also indicated that excessive arousal is likely to disrupt sleep quality (Mozafari Zadeh et al., 2019). These discussions highlight the relevance of arousal regulation in relation to sleep issues. It is conceivable that athletes' arousal levels increase during physical exercise because their nervous systems are stimulated by training stressors (Nien et al., 2024). The possibility of reducing arousal (calming) through mindfulness-related strategies prompted the present researchers to consider the use of a brief mindfulness intervention (focusing on one's breathing) to improve sleep. Specifically, mindfulness as a mindfulness practice has been shown to reduce heart rate and effort compared to loving-kindness meditation and thought-observation meditation (Teasdale, 2006; Teasdale et al., 1995; van de Water et al., 2017, Namaki et al., 2022). Therefore, the findings of this study are consistent with previous research and indicate that mindfulness training is effective on arousal in adolescent athletes. In the study, the researcher used a general and non-specific rumination questionnaire to study the effect of mindfulness on anger, hostility, and verbal and physical aggression through rumination and concluded that rumination partially mediates the effect of mindfulness on anger and aggression (Zaal et al., 2020). As mentioned, there has been little research on anger, especially anger in sports; but if mindfulness helps social well-being and reduces anxiety and stress in athletes, then mindfulness training can undoubtedly be effective on athletes' anger and reduce it. The results of this study were also

effective in reducing the anger component of emotional output; but more research is recommended in this field. The researchers argued that the increase in self-concept and self-esteem associated with mindfulness practice is necessary for these practices to create positive self-concept and self-esteem. Self-concept and mindfulness could be due to having a symbiotic relationship or a reward system. Research has shown that mindfulness practice increases self-concept. As self-concept increases and individuals begin to feel better about themselves, they become more inclined to practice mindfulness (Vealey et al., 1998). The basis for using mindfulness skills is to create positive feelings, a better life, and greater happiness; however, unfortunately, happiness and its relationship to mindfulness training have not been specifically studied. Since mindfulness is derived from the thoughts of Buddha and this method has been a method for creating a better life and greater happiness in ancient Eastern culture, it can be inferred that happiness is one of the main goals of mindfulness. The results of the present study also confirm this claim.

5. Conclusions

The results of this study indicate the usefulness of mindfulness-based neuropsychological skills training on behavioral, cognitive, and emotional sports performance; therefore, it is concluded that the mindfulness-based neuropsychological skills training program can be used as an appropriate program to increase athletes' performance.

Practical research suggestions- The results of the present study showed that training in neurological skills based on the efficiency of mindfulness variables on behavioral, cognitive, and sports emotion among adolescent athletes aged 10 to 17 reduces physical and cognitive anxiety, so these techniques can be used to reduce anxiety in competitive and non-competitive environments.

- The results of the present study showed that training in neurological skills based on the efficiency of mindfulness variables on behavioral, cognitive, and sports emotion among adolescent athletes aged 10 to 17 increases self-confidence; therefore, these techniques can be used to increase self-confidence.

- The results of the present study showed that training in neurological skills based on the efficiency of mindfulness variables on behavioral, cognitive, and sports emotion among adolescent athletes aged 10 to 17 reduces physical and cognitive anxiety; therefore, it is suggested that mindfulness techniques be used more in addition to other techniques to reduce physical and cognitive anxiety, but the positive effects of other techniques should not be ignored.

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Declaration of Conflicting Interests and Ethics

The authors declare no conflict of interest.

References

- Abadie, B. R. (1988). Construction and validation of a perceived physical fitness scale. *Perceptual and Motor skills*, 67(3), 887-892.
- Bigelow, H., Gottlieb, M. D., Ogrodnik, M., Graham, J. D., & Fenesi, B. (2021). The differential impact of acute exercise and mindfulness meditation on executive functioning and psycho-emotional well-being in children and youth with ADHD. *Frontiers in Psychology*, 12, 660845.
- Bondar, R. Z., Bertollo, M., di Fronso, S., & Robazza, C. (2024). Mindfulness to performance enhancement: a systematic review of neural correlates. *International Review of Sport and Exercise Psychology*, 17(1), 65-93.
- Brito, M. A. d., Fernandes, J. R., Esteves, N. S. A., Müller, V. T., Alexandria, D. B., Pérez, D. I. V., Slimani, M., Brito, C. J., Bragazzi, N. L., & Miarka, B. (2022). The effect of neurofeedback on the reaction time and cognitive performance of athletes: A systematic review and meta-analysis. *Frontiers in Human Neuroscience*, 16, 868450.
- Bühlmayer, L., Birrer, D., Röthlin, P., Faude, O., & Donath, L. (2017). Effects of mindfulness practice on performance-relevant parameters and performance outcomes in sports: A meta-analytical review. *Sports medicine*, 47, 2309-2321.
- Corrado, S., Tosti, B., Mancone, S., Di Libero, T., Rodio, A., Andrade, A., & Diotaiuti, P. (2024). Improving mental skills in precision sports by using neurofeedback training: a narrative review. *Sports*, 12(3), 70.
- Crivelli, D., Fronda, G., & Balconi, M. (2019). Neurocognitive enhancement effects of combined mindfulness–neurofeedback training in sport. *Neuroscience*, 412, 83-93.
- Farsi, A., & Zamani, H. (2014). Investigation of factor structure of sources of sport self-confidence questionnaire among female and male university athletes in group and individual sports. *Sport Psychology Studies*, 3(8), 18-11.
- Gardner, F. L., & Moore, Z. E. (2019). Mindfulness in sport: Neuroscience and practical applications.
- Gardner, F. L., & Moore, Z. E. (2020). Mindfulness in sport contexts. *Handbook of sport psychology*, 738-750.
- Heckman, C. (2018). The effect of mindfulness and meditation in sports performance. *Kinesiology, sport studies, and physical education synthesis projects*, 47.
- Hemayat Talab, R., Khabiri, M., & Zare, M. (2016). Psychometric properties of persian version of Mindfulness Inventory for Sport (MIS). *Sport Psychology Studies*, 5(18), 63-80.
- Holfelder, B., Klotzbier, T. J., Eisele, M., & Schott, N. (2020). Hot and cool executive function in elite-and amateur-adolescent athletes from open and closed skills sports. *Frontiers in Psychology*, 11, 694.
- Isbel, B. D., Lagopoulos, J., Hermens, D. F., & Summers, M. J. (2019). Mental training affects electrophysiological markers of attention resource allocation in healthy older adults. *Neuroscience letters*, 698, 186-191.
- Jalali, D., Aghaei, A., Talebi, H., & Mazaheri, M. A. (2015). Comparing the effectiveness of nated mindfulness based cognitive training (mbct) and cognitive–behavioral training on dysfunctional attitudes and job affects in employees. *Research in Cognitive and Behavioral Sciences*, 5(1), 1-20.
- Jones, M. V., Lane, A. M., Bray, S. R., Uphill, M., & Catlin, J. (2005). Development and validation of the sport emotion questionnaire. *Journal of Sport and Exercise psychology*, 27(4), 407-431.
- Josefsson, T., Ivarsson, A., Gustafsson, H., Stenling, A., Lindwall, M., Tornberg, R., & Böröy, J. (2019). Effects of mindfulness-acceptance-commitment (MAC) on sport-specific dispositional mindfulness, emotion regulation, and self-rated athletic performance in a multiple-sport population: an RCT study. *Mindfulness*, 10, 1518-1529.
- Kabat-Zinn, J. (2012). *Mindfulness for beginners: Reclaiming the present moment-and your life.* (No Title).

- Kaufman, K. A., Glass, C. R., & Pineau, T. R. (2019). Mindful sport performance enhancement (MSPE). In *Handbook of mindfulness-based programmes* (pp. 173-190). Routledge.
- McGrane, B., Belton, S., Powell, D., Woods, C. B., & Issartel, J. (2016). Physical self-confidence levels of adolescents: Scale reliability and validity. *Journal of Science and Medicine in Sport*, 19(7), 563-567.
- Mitsea, E., Drigas, A., & Skianis, C. (2023). Digitally assisted mindfulness in training self-regulation skills for sustainable mental health: a systematic review. *Behavioral Sciences*, 13(12), 1008.
- Moen, F., Hrozanova, M., & Stiles, T. (2018). The effects of perceptual-cognitive training with Neurotracker on executive brain functions among elite athletes. *Cogent Psychology*, 5(1), 1544105.
- Mozafari Zadeh, M., Heidari, F., & Khabiri, M. (2019). Effectiveness of mindfulness and acceptance training on reducing sport injury anxiety and improving performance of soccer players. *The Scientific Journal of Rehabilitation Medicine*, 8(1), 95-108.
- Namaki, I. M., HASHEMI, N. T., NAZARI, V., & BEYRAMI, M. (2022). Determining the Effectiveness of Mindfulness-Based Neurocognitive Skills Training on Behavioral, Cognitive, and Emotional Efficiency of Male Wrestling Athletes.
- Nien, J.-T., Chen, N.-C., Kee, Y.-H., Wu, C.-H., Ahn, J., Yu, C.-Y., Chi, L., & Chang, Y.-K. (2024). Athletes with meditation experience counteract the detrimental effect of mental fatigue on endurance performance and neurocognitive functions. *Journal of Sports Sciences*, 42(14), 1355-1366.
- Ross, S. R., & Keiser, H. N. (2014). Autotelic personality through a five-factor lens: Individual differences in flow-propensity. *Personality and individual differences*, 59, 3-8.
- Sachs, M., Kaplan, J., Der Sarkissian, A., & Habibi, A. (2017). Increased engagement of the cognitive control network associated with music training in children during an fMRI Stroop task. *PloS one*, 12(10), e0187254.
- Segal, Z., Williams, M., & Teasdale, J. (2012). *Mindfulness-based cognitive therapy for depression*. Guilford press.
- Serin, E., & Taşkın, H. (2016). Anaerobik dayanıklılık ile dikey sıçrama arasındaki ilişki. *Spor ve Performans Araştırmaları Dergisi*, 7(1), 37-43.
- Serin, E. (2019). Profesyonel, amatör ve sedanter futbol oynayanların fiziksel, fizyolojik ve motorik özelliklerinin değerlendirilmesi-anaerobik dayanıklılıklarını etkileyen faktörlerin belirlenmesi. *CBÜ Beden Eğitimi ve Spor Bilimleri Dergisi*, 14(2), 344-355.
- Serin, E. (2020). Aerobik antrenmanların vücut kompozisyonu üzerine etkisi. *Dünya Sağlık ve Tabiat Bilimleri Dergisi*, 3(1), 17-24.
- Serin, E., & Okludil, K. (2020). Nörogelişimsel hareket eğitimi ve spor. *Dünya Sağlık ve Tabiat Bilimleri Dergisi*, 3(1), 45-58.
- Su, N. (2020). The effects of a mindfulness and acceptance-based training program on relevant psychological factors and sport training performance in hong kong elite adolescent athletes.
- Su, N., Si, G., Liang, W., Bu, D., & Jiang, X. (2024). Mindfulness and acceptance-based training for elite adolescent athletes: a mixed-method exploratory study. *Frontiers in Psychology*, 15, 1401763.
- Teasdale, J. D. (2006). *Mindfulness-based cognitive therapy for depression*. In *Buddhist Thought and Applied Psychological Research* (pp. 450-466). Routledge.
- Teasdale, J. D., Segal, Z., & Williams, J. M. G. (1995). How does cognitive therapy prevent depressive relapse and why should attentional control (mindfulness) training help? *Behaviour Research and therapy*, 33(1), 25-39.
- Van de Water, T., Huijgen, B., Faber, I., & Elferink-Gemser, M. (2017). Assessing cognitive performance in badminton players: a reproducibility and validity study. *Journal of human kinetics*, 55, 149.
- Vealey, R. S., Garner-Holman, M., Hayashi, S. W., & Giacobbi, P. (1998). Sources of sport-confidence: Conceptualization and instrument development. *Journal of Sport and Exercise psychology*, 20(1), 54-80.

- Zaal, B., Arab, A., & Sanagouye-Moharer, G. R. (2020). Comparing the effects of forgiveness and self-compassion training on marital conflicts in females facing marital infidelity. *Middle Eastern Journal of Disability Studies*, 10, 192-192.
- Zhu, Y., Sun, F., Li, C., Huang, J., Hu, M., Wang, K., He, S., & Wu, J. (2022). Acute effects of mindfulness-based intervention on athlete cognitive function: An fNIRS investigation. *Journal of Exercise Science & Fitness*, 20(2), 90-99.
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