Clinical Psychology: Research and Practice Innovations

Online ISSN: 3115-9508

Homepage: https://cprpi.semnan.ac.ir

Semnan University

The Effect of Acute Mental Fatigue on the Performance of Sports Coaches

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ARTICLE INFO

Article type:
Research Article

Article history:
Received: 02 December 2024
Received in revised form: 15 June 2025
Accepted: 19 June 2025
Published Online: 31 December 2025

Keywords:
Mental Fatigue,
Acute Training,
Sports Performance,
Sports Coaches

ABSTRACT

Background: One of the most important concerns related to sports performance is mental fatigue. Fatigue, in particular, manifests itself as a lack of willingness to exert effort, reduced alertness and efficiency, and cognitive dysfunction. The main objective of this study was to investigate the effect of acute mental fatigue on the performance of sports coaches.

Method: This study is classified as a quasi-experimental study with regard to its practical objectives and methodological approach. The present study was conducted as a pre-test and post-test. The statistical population included all male sports coaches of various group and individual disciplines in Isfahan province, aged 25 to 40, from whom 20 were selected through convenience sampling. Descriptive statistics were used to analyze the data, and the Shapiro-Wilk test was used to examine the normality of the data distribution, and repeated-measures analysis of variance was used to test the research hypotheses.

Results: The findings of this study showed that the effect of mental fatigue on eight subscales of the McLean and Lacroix Coaches Performance Questionnaire, except for the financial factor, was significantly influential on the remaining subscales.

Conclusion: It can be concluded that a cognitive task training session causes mental fatigue and can have a negative effect on the performance of sports coaches, but the effect of its level on gender and coaches with different levels of expertise requires further investigation in future research.

Citation: Alirezaei Dizicheh, M.R., Golmohammadi, B., & Kashani, V. (2025). The Effect of Acute Mental Fatigue on the Performance of Sports Coaches. *Clinical Psychology: Research and Practice Innovations*, 17(4), 67-77.

DOI: https://doi.org/10.22075/jcp.2025.36124.3065

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Extended Abstract

Introduction

Sport is recognized as a key driver of economic productivity and wealth generation and plays a significant role in the economy at the personal, organizational and national levels. Mental fatigue (MF) can be defined as a psychological state that occurs due to a required cognitive activity. Although mental fatigue is temporary in nature, it can have a significant negative impact on performance and safety. In the success of a sports team that depends on the athlete, coach and spectators, the coach plays an important role in leading and guiding the team and serves as a skilled and essential organizer for any progress. The coach, who is recognized as the main and central figure in the sports landscape, is responsible for developing the technical, physical and moral skills of athletes. According to previous studies on mental fatigue and the performance of sports coaches, it seems that mental fatigue affects the motivation to continue working, concentration and timely decision-making, mood and overall performance of sports coaches. Therefore, the purpose of this research is to determine whether mental fatigue can affect the performance of sports coaches.

Method

The research design included pre-test and post-test measures. The statistical population studied in this study included all semi-skilled male sports coaches in the age group of 25 to 40 years in Isfahan province. A total of 20 male sports coaches from various group and individual disciplines who met the necessary conditions were selected as available for inclusion in the study. In order to examine the performance evaluation indicators of club coaches, the McLean and Zakrajsk questionnaire was used. McLean and Zakrajsk evaluated the internal reliability of this tool as 0.78 for sports managers and 0.76 for coaches. Ramezani Nejad et al. also reported the overall reliability coefficient of the tool using the Cronbach's alpha correlation coefficient of 0.75. The research was conducted as follows: first, the participants completed the personal information questionnaire, the MFI multidimensional fatigue questionnaire, the VAS visual acuity scale, and the McLean and Zakrajsk club coach performance questionnaire as a pre-test. According to the aim of the study, the participants were subjected to a mental fatigue intervention. After that, the MFI multidimensional fatigue questionnaire and the VAS visual acuity scale were completed once again, and their performance was compared before and after the mental fatigue intervention. For data analysis, descriptive statistics (mean and standard deviation) were used to express the research variables and draw tables and graphs. In the inferential statistics section, the Shapiro-Wilk test was used to examine the natural distribution of the data, and the repeated-measures analysis of variance was used to test the research hypotheses.

Results

The population of the present study included all male sports coaches of various group and individual disciplines in Isfahan province in 2024. The inclusion criteria for the study included: having coaching experience at the national level, no previous participation in the national team, and individual satisfaction. The average age and coaching experience of the coaches were 32.05 and 7.10 years, respectively. In the post-test phase, compared to the pre-test, the performance of the participants in terms of the mean values in the sport Coaches performance questionnaire showed a significant decrease. Also, in the post-test phase, compared to the pre-test, the level of mental fatigue of the coaches in terms of the mean values in the mental fatigue measurement test increased. The distribution of the data collected in the pre-test phase, the scores of the sport Coaches performance questionnaire after the Stroop effect test were normal, therefore, to test the research

hypotheses, the use of inferential statistics using the parametric method and the analysis of variance test with repeated measures is appropriate and permissible.

Table 1. Results of repeated-measures analysis of variance test to ¬investigate the role of acute mental fatigue on performance factors of coaches

Agents	Resources	Degrees of freedom	Average Squares	F	Level Meaningfulness	Effect size
Maintaining the team	Time	1	1742.400	98.353	0.001	0.838
	Error	19	17.716			
Coach's work and technical behaviors	Time	1	1392.400	81.502	0.001	o.811
	Error	19	17.084			
Athlete training and development	Time	1	577.600	85.470	0.001	0.818
	Error	19	6.758			
Public Relations	Time	1	99.225	36.065	0.001	0.655
	Error	19	2.751			
Getting to know the team	Time	1	198.025	82.737	0.001	0.813
	Error	19	2.393			
Finance	Time	1	0.025	0.033	0.858	0.002
	Error	19	0.762			
Team performance	Time	1	15.625	14.222	0.001	0.428
	Error	19	1.099			
Coach's technical performance	Time	1	52.900	55.530	0.001	0.745
	Error	19	0.953			

The results of the repeated-measures analysis of variance test indicate that the performance of sports coaches in the Sports Coaches Performance Questionnaire is affected by mental fatigue and this change is significant. Mental fatigue significantly caused a decrease in the factors of team maintenance, coach work and technical behaviors, athlete training and development, public relations, team recognition, team performance, and coach technical performance in the Coaches Performance Questionnaire, but no significant decrease was observed in the factor of financial affairs.

Conclusion

This study aimed to investigate the effect of acute mental fatigue on the performance of semi-skilled sports coaches. The results of the repeated-measures analysis of variance test indicate that mental fatigue had a significant effect on seven sub-factors of team maintenance, coach's work and technical behaviors, athlete training and development, public relations, team recognition, team performance, and coach's technical performance, and caused a decrease in performance in these sub-scales, but no significant effect was observed in the financial affairs sub-scale. This finding was consistent with the results obtained by Etani et al., Azevedo et al., Smith et al., Venis et al., and Harris et al. One of the potential reasons for the effect of mental fatigue on sports performance is probably due to the theories confirmed in neuroscience and psychology that show that mental fatigue reduces cognitive abilities and, as a result, affects functions such as information processing, concentration, and decision-making, which, as a result, can lead to a decrease in overall performance. Given that mental fatigue is associated with decreased cognitive performance, there is a growing interest among coaches and researchers in monitoring performance while individuals engage in tasks that cause mental fatigue. Key measures of interest include reaction time, response accuracy, and attention levels. The research of Matias et al. and Pena et al. is inconsistent with the present study. In explaining the reasons for the inconsistency with the results of these studies, it can be said that in the study of Matias et al. and Pena et al., the study was

conducted on elite athletes, while in the results of the present study, the study was conducted on the performance of semi-skilled male sports coaches.

Ethical Considerations

Ethics Code: In order to comply with the issue of social desirability, written consent was obtained from the participants to participate in this study, while declaring the confidentiality of the information collected.

Financial support: This study was conducted without financial support.

Authors' Contributions: Data collection was carried out by student M. Alirezaee. The article was compiled and written by B. Golmohammadi, and the statistical analysis of the collected data was conducted by V. Kashani.

Conflict of Interest: According to the authors, there was no conflict of interest in this study.

Acknowledgments: We would like to thank all the instructors who participated in this study.

Introduction

Over the past two decades, sports have been increasingly recognized as a pivotal social structure, holding significant importance on a global scale. Sports not only are considered a key driver of economic productivity and wealth generation but also play a significant role in individual, organizational, and national economies (1). Sports are currently recognized as one of the world's 20 largest industries, valued at approximately $500 billion (2). The expansion of sports activities and their widespread dissemination through various media systems have significantly increased the popularity of professional athletes and coaches.

Mental fatigue, defined as a psychophysiological state induced by a demanding cognitive activity, manifests in various forms and is associated with an increased probability of errors and slower response times when performing basic cognitive tasks (3, 4). It is also accompanied by changes in brain efficiency, which are closely linked to the reward system, mental focus, and motivation (5, 6). Subjectively, individuals report increased feelings of fatigue, stemming from insufficient energy as well as reduced motivation and alertness. Although mental fatigue, i.e., changes in the one's psychophysiological state resulting from sustained performance (7), is temporary in nature, acute mental fatigue can have a significant negative impact on performance and safety (8). Van Cutsem et al. (9) acknowledge that mental fatigue affects cognitive performance. In previous studies, no difference has been observed between men and women regarding the effects of mental fatigue (10, 11).

In the success of a sports team, which hinges on the athletes, coach, and spectators, the coach assumes a critical role in leading and guiding the team, serving as a skilled and essential organizer for any advancement. Recognized as the pivotal and central figure in the sporting landscape, the coach is responsible for nurturing athletes' technical, physical, and moral skills (12). Draco (13) views coaching as an educational task that can substantially contribute to enhancing athletes' progress in sports. Leroux (14) also holds the view that although coaching may not be globally considered one of the most challenging professions, not everyone possesses the requisite characteristics to excel as a coach. Consequently, the role of a coach is multifaceted, meaning that coaches require a combination of expertise and skill in their own field as well as a deep understanding, discernment, and empathy towards themselves and others. Meanwhile, they should be able to effectively foster a strong emotional commitment and connection with the sport.

Sports coaches undergo significant emotional labor as they experience a wide range of positive and negative emotions, which necessitates effectively regulating their feelings and selecting emotions appropriate to the situation for advancing towards their goals (15). For example, athletes' critical errors or referees' poor performance can provoke anger in coaches,

potentially resulting in negative outcomes for the coaches, teams, and athletes (16). The findings of previous research on sports coaches attest to the undeniable effect of coaches' emotional labor on their appraisal of harm in different ways. Furthermore, unlike staff and managers, coaches are typically present in public spaces such as arenas and sports centers during competitions. This presence may involve engaging in hazardous activities, such as direct physical altercations with athletes or opponents, thereby imposing a higher emotional toll than other leadership roles (17, 18). Therefore, this emotionally demanding profession can be associated with several negative outcomes such as burnout, diminished work enthusiasm, and job dissatisfaction (19). The extant literature indicates that coaches utilize a wide range of psychological skills to help their athletes manage the competitive and organizational demands imposed upon them (20).

According to previous studies, individuals tend to gravitate towards tasks in which they feel capable and confident, while avoiding those they perceive as beyond their abilities (21). Given the link between mental fatigue and sports coaches' performance, mental fatigue may influence coaches' beliefs, motivation to persist, concentration, and timely decision-making as well as their mood and overall performance. Therefore, the purpose of this study is to determine whether mental fatigue can affect the performance of sports coaches.

Method

Research Design: The present study was quasi-experimental, utilizing a pre- and post-test design. Prior to data collection, written informed consent was obtained from all participants, and they were fully informed about the research protocols.

Participants: The statistical population consisted of all semi-professional male sports coaches aged 25 to 40 in Isfahan province. A total of 20 male sports coaches who met the inclusion criteria were selected from various team and individual disciplines using convenience sampling.

Instruments

1. Demographic Information Questionnaire: This questionnaire was used to collect the participants' personal information including age, gender, and coaching experience.

2. Multidimensional Fatigue Inventory (MFI): This inventory is a highly comprehensive instrument which provides deep and precise insights into individuals' fatigue level. Essentially, the MFI measures fatigue based on how individuals perceive and express it (22). This survey instrument consists of five sub-scales and 20 items measuring mental fatigue on a five-point Likert scale ranging from 1 (Strongly Agree) to 5 (Strongly Disagree). The total score for each dimension ranges from 4 to 20, and the overall questionnaire score is obtained by summing the scores of all items. The minimum achievable score is 20 while the maximum is 100, with higher scores being associated with higher fatigue levels. The internal validity of this questionnaire was checked and confirmed using confirmatory factor analysis. As for its reliability, the Cronbach alpha coefficient for the three sub-scales of general, physical, and mental fatigue were above 0.80 and for reduced activity and motivation exceeded 0.65. It should be noted that previous studies have also shown the high reliability of this instrument (24).

3. Visual Analogue Scale (VAS): This scale measures participants' mental fatigue with numbers ranging from 0 to 100 (25). On this scale, a score of 100 indicates the highest level of fatigue, while a score of 0 represents the lowest level of mental fatigue (i.e., the highest level of alertness).

4. McLean and Zakrajsek Coaching Performance Questionnaire: This questionnaire, originally designed to assess the performance of university coaches in Canada, consists of 50 five-point Likert scale items ranging from 1 (Strongly

Disagree) to 5 (Strongly Agree) and comprises eight factors: team retention and maintenance, work and technical behaviors, athlete training and development, public relations, team knowledge, financial affairs, team performance, and technical performance (26). The minimum and maximum possible scores on this questionnaire are 50 and 250, respectively. McLean and Zakrajsek assessed the internal reliability of this instrument, reporting the Cronbach alpha coefficients of 0.78 and 0.76 for athletic directors and coaches, respectively. Ramezaninezhad et al. (27) also reported the overall reliability coefficient of the instrument as 0.75.

It should be noted that numerous studies have examined and confirmed the face, factorial, and content validity of this instrument and reported its high reliability. In the present study, the face validity of the Persian version of this instrument was checked by five professors in the field of sports sciences. Based on the accuracy of the translation and the clear wording of the questions in each factor, the face and content validity of this questionnaire were also confirmed by these professors. It is noteworthy that since its internal reliability has been reported as adequate in various studies, the present research relied on the values reported in past research (27).

Research implementation process: The research protocol involved a meticulous process wherein participants were selected based on their availability. Next, the study's objectives and procedures were clearly explained for them, and they provided their informed consent and essential personal details. Initially, the participants responded to the items of the four data collection instruments in the pre-test phase.

In line with the study objective, the participants underwent a mental fatigue intervention based on previous research (28, 29), resulting in increases in their mental fatigue scores above the mean. Following the initial assessment of mental fatigue, the participants were collectively administered an online incongruent Stroop effect test for 60 minutes. This test was executed online using a computer, where four distinct words—red, green, blue, and yellow—were randomly displayed on the screen. To provide a correct response, individuals were required to identify the ink color while disregarding the word itself. To ensure the participants' focus on the task, they were requested to achieve the maximum number of accurate responses in the shortest possible reaction time. Prior to the main test, the participants completed a 5-minute familiarization trial, a method commonly employed in previous studies (30). Subsequently, their fatigue was measured again using MFI and VAS. Finally, after confirming that the coaches' mental fatigue scores were above the mean (i.e., above 60), they were asked to complete the coaching performance questionnaire. The participants' performance was then compared before and after the mental fatigue intervention.

Statistical Analysis Method

Both descriptive and inferential statistics were used to analyze the collected data. Descriptive statistics (e.g., mean and standard deviation) were utilized to describe the research variables and construct tables and graphs. Regarding inferential statistics, the Shapiro-Wilk test was used to assess the normality of the data distribution, and a repeated measures analysis of variance (ANOVA) was employed to test the research hypotheses. The collected data were analyzed using SPSS software (version 24). The significance level for all statistical tests was set at $\alpha=0.05$.

Results

The population of the present study comprised all male sports coaches from various team and individual disciplines in Isfahan province in the year 2024. The inclusion criteria were having coaching experience at the national level, no prior history of involvement with national teams, and providing informed consent.

Table 1. Participants' Demographic Information

Variable	N	Mean	SD
Age	20	32.05	5.20
Coaching experience	20	7.10	3.30

As shown in Table 1, the mean age and coaching experience of the coaches were 32.05 and 7.10 years, respectively.

Table 2. Descriptive Statistics related to Coaches' Performance in the Pre- and Post-test phases

Test phases	Dependent Variable	N	Mean	SD
Pre-test	Coaching performance	20	194.75	15.59
Post-test	Coaching performance	20	151.95	13.256
Pre-test	Mental fatigue	20	19.5	7.7
Post-test	Mental fatigue	20	37.45	13.1

As shown in Table 2, there is a significant decline in the participants' performance in the post-test in comparison to the pre-test. Additionally, there is an increase in coaches' mental fatigue in the post-test phase.

Table 3 shows that the distributions of the collected data at the pre-test phase as well as that of the participants' scores based on the coaching performance questionnaire after the Stroop test were normal. Therefore, to test the research hypotheses, the use of repeated measures analysis of variance (ANOVA), as the parametric inferential statistics, was appropriate and justified.

Table 3. Results of the Shapiro-Wilk Test for Assessing Data Normality

Test Stage	Statistic	df	Sig.	Status
Pre-test	0.955	20	0.452	Normal data distribution
Post-Stroop test	0.937	20	0.212	Normal data distribution

Table 4. Results of the Repeated Measures ANOVA to Examine the Effect of Acute Mental Fatigue on the Performance of Sports Coaches

Source	df	Mean Square	F	Sig.	Effect Size
Time	1	16160.400	281.282	< 0.001	0.937
Error	19	376.058			

As shown in Table 4, the results of the repeated measures ANOVA indicate that the performance of sports coaches significantly declined due to mental fatigue.

Table 5. Results of the Repeated Measures ANOVA to Examine the Role of Acute Mental Fatigue on Different Dimensions of Coaching Performance

Performance Dimensions	Source	Degrees of freedom	Average Squares	F	Significance Level	Effect size
Maintaining the team	Time	1	1742.400	98.353	0.001	0.838
	Error	19	17.716			
Work and technical behaviors	Time	1	1392.400	81.502	0.001	o.811
	Error	19	17.084			
Athlete training and development	Time	1	577.600	85.470	0.001	0.818
	Error	19	6.758			
Public relations	Time	1	99.225	36.065	0.001	0.655
	Error	19	2.751			
Getting to know the team	Time	1	198.025	82.737	0.001	0.813
	Error	19	2.393			
Finance	Time	1	0.025	0.033	0.858	0.002
	Error	19	0.762			
Team performance	Time	1	15.625	14.222	0.001	0.428
	Error	19	1.099			
Technical performance	Time	1	52.900	55.530	0.001	0.745
	Error	19	0.953			

As shown in Table 5, mental fatigue caused a significant decline in the factors of team retention and maintenance, work and technical behaviors, athlete training and development, public relations, team knowledge, team performance, and the coach's technical performance on the coaching performance questionnaire. However, no significant decline was observed for the financial affairs factor.

Discussion

This study aimed to investigate the effect of acute mental fatigue on the performance of semi-professional sports coaches. To this end, 20 semi-professional male coaches voluntarily participated in the research. The data collection instruments included the Stroop task, the Multidimensional Fatigue Inventory (MFI), the Visual Analogue Scale (VAS), and the McLean and Zakrajsek Coaching Performance Questionnaire. The participants underwent a 60-minute intervention with the Stroop task on two separate days. After each session, their fatigue levels and performance were measured.

The results indicated that the performance of sports coaches significantly declined following the induction of mental fatigue. Furthermore, the results of the repeated measures ANOVA confirmed that mental fatigue significantly reduced the coaches' performance in terms of seven dimensions, namely, team retention and maintenance, work and technical behaviors, athlete training and development, public relations, team knowledge, team performance, and technical performance while having no significant effect on coaches' financial affairs.

This finding is consistent with the results of past studies by Otani et al. (31), Azevedo et al. (32), Smith et al. (33), Veness et al. (34), and Harris et al. (35). For example, Azevedo et al. (32) reported decreases in coaches' performance up to 80% of their maximal power output when experiencing mental fatigue. Also, Otani et al.'s (31) study revealed that mental fatigue can decrease oxygen uptake by 20%. Additionally, Smith et al. (33) showed that mental fatigue reduced running speed at low intensities. The observed performance impairments in this study could be attributed to coaches' higher perception of effort, rather than to physiological differences, under the mental fatigue condition. Last but not the least, Veness et al. (2017) also observed similar findings in elite cricket players.

The findings of the present study also echo those of Trecroci et al.'s (36) study investigating the effect of mental fatigue on physical activity, technical performance, and decision-making in football players, which indicated a decline in decision-making and technical performance in semi-professional football players under conditions of mental fatigue. A possible explanation for the effect of mental fatigue on cognitive performance is that cognitive abilities encompass a set of mental processes through which an individual processes information and makes appropriate decisions. In fact, cognitive performance consists of multiple components that form an integrated system (37). This type of performance describes the complete process of how information is received, used, and reacted by individuals. Information processing begins with the identification of environmental stimuli, followed by the perception and interpretation of the sensory stimuli, leading individuals to think about the perceived information. Therefore, cognitive performance is the process of identifying, interpreting, storing, making decisions, and acting with appropriate speed, accuracy, and efficiency (38).

The potential reasons for the impact of mental fatigue on athletic performance could stem from established theories in neuroscience and psychology, which state that mental fatigue diminishes cognitive abilities, thereby affecting functions such as information processing, concentration, and decision-making and consequently overall performance. Given that mental fatigue is associated with decreased cognitive performance, there has been a growing interest among coaches and researchers in focusing on performance, especially when individuals engage in cognitively demanding tasks that could induce mental fatigue, possibly affecting their reaction time, response accuracy, and attention levels. Reaction time represents the duration between the presentation of a stimulus and a participant's corresponding response;

response accuracy measures the percentage of correct responses within a specific time frame; and attentional lapses denote instances where stimuli are presented without a corresponding response. As a result, increases in reaction time and attentional lapses and decreases in response accuracy may serve as indicators of the presence of mental fatigue (39, 40, 41).

Harris et al. (35) conducted a study to examine the effect of mental fatigue on decision-making in sports. In their study, participants performed a 10-minute incongruent Stroop cognitive task followed by a 22-minute moderate-to-vigorous exercise task. The results indicated that decision-making ability showed a significant decrease during the fatigued state compared to the non-fatigued state.

Men and women have been shown to exhibit differences in their perceptions of and responses to stress when experiencing mental fatigue (42). The findings of Mathias et al. (6) and Pena et al. (42) are inconsistent with the present study. Mathias et al. investigated the effect of acute mental fatigue on the performance of elite badminton athletes, indicating that although mental fatigue was higher after the Stroop task compared to the control condition, performance during the specialized badminton test was not negatively affected, and no differences in physiological measures were observed. Similarly, Pena et al.'s findings revealed that mental fatigue had no effect on the physical performance of the skilled swimmers.

In explaining the inconsistency of the obtained findings with those of the previous studies, it should be noted studies by Mathias et al. and Pena et al. were conducted on elite athletes, whereas the participants of the present study were semi-professional sports coaches. Furthermore, some studies have paid especial attention to gender differences, indicating the varied impact of mental fatigue on male and female athletes. Since the present study was conducted exclusively on male coaches, the differential impact of mental fatigue across genders could not be determined. Additionally, the lack of information regarding the coaches' psychological and emotional states before and during the study constitutes another limitation. Finally, as the study was conducted on sports coaches from the Isfahan province, the results may not be generalizable to coaches working in other geographical areas.

The adverse effects of mental fatigue on the effectiveness of sports coaches highlight the importance of limiting cognitively demanding activities in the hours preceding a competitive event. It is recommended that sports coaches manage controllable factors to reduce their mental fatigue, which can help them achieve optimal results. Furthermore, given the essential role of sports psychologists in managing the adverse effects of mental fatigue on the athletic performance of coaches, it is recommended that all professional sports teams pay especial attention to the guidance provided by sports psychologists.

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