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The Effect of Mental Fatigue on the Accuracy of the Direct Free Kick in Terms of Some Kinematic Variables for Football Players

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Abstract

Background: Mental fatigue is one of the phenomena associated with the skillful sports performance of football players. There is a link between mental fatigue and the quality of skillful performance. It occurs during or after a mental activity, which is reflected in a decrease in physical fitness and a reduction in the ability to focus.
Objectives: This study was designed to find the association between mental fatigue and skill performance by inferring the kinematic variables. Sports skills demand excellent performance that is connected to mindfulness. Mental weariness impacts a person's ability to perform physically and skillfully in a sport, especially if that performance requires high accuracy and intensity.
Methods: The empirical research consisted of 24 players specializing in direct free kicks. Test for the accuracy of free kick shooting, a mental fatigue experiment, and a re-test of direct free kick shooting was performed and analyzed through Kinovea 0.9.5 software.
Results: The mean difference in the fatigue level of players before and after concerning the kinematic variables among football players was found to be statistically significant (P-value < 0.001).
Conclusions: The study recommended developing programs that support the mental stability of the player during matches to be able to continue the required skill performance, no matter how much mental fatigue he is exposed to, which occurs as a result of several circumstances during football matches.

Keywords: Mental Fatigue, Direct Free Kick, Kinematic Variables, Football

1. Background

The state of mental fatigue is the reaction of some specific behavior that makes the brain tired from the routine. This is also called the psychobiological state, in which prolonged specific action decreases cognitive activity, which affects physical performance. There are many factors and manifestations of mental fatigue. It is believed that when the brain is suffering from stress, tiredness, and fatigue, it directly provides negative impacts on physical activities like performance in sports. Behavior change, loss of concentration, increase in demotivation, and loss of enthusiasm are the main descriptors of mental fatigue. Environmental factors are also involved, such as over-analysis in thinking and repetition of the task (1). The occurrence of mental fatigue is reflected in a decrease in physical fitness and in the ability to focus (2). Pageaux and Lepers (3) reported that studying the impact of mental fatigue on physical performance in either physical or skill sports is a modern scientific approach in which further studies with multiple and diverse experimental groups are needed.

2. Objectives

The ability of humans is deeply affected by the disturbances in the environment caused due to any reason. This will paralyze skill and judgment. This ability is highly developed in elite athletes, who, unlike less talented players, can generally retain perceptual and performance precision in the face of numerous shifts. They can retain the intense pressure that emerges in competitive sports scenarios (4). In reality, competitive performance scenarios frequently require the athlete to address many tasks simultaneously. Movement automaticity is an important aspect of an athlete's ability to do various jobs. For instance, competent football players may pick whether to transfer the ball to a teammate, shoot on goal, or dexterously dribble at opponents while maintaining possession of the ball. Less talented players, on the other hand, must pay attention to their actions and the ball, which requires a significant number of cognitive resources.

Sports skills demand excellent performance that is connected to mindfulness. Usually, mental exhaustion impacts a person's ability to perform physically and skillfully.

It impacts the activities for which performance requires high accuracy and intensity (5). The ability of a team to withstand mental fatigue can contribute to winning championships against another team, even if the two teams are equally skilled and physically fit. This is demonstrated in football, a sport that requires multiple mental knowledge processes associated with making important decisions in a concise amount of time and associated with a skill performance that combines speed, strength, and accuracy (6).

Physical skill and performance are what mental knowledge uses to improve the player's behavior. The players need mental and cognitive requirements to focus on skills that demand focus on understanding playing scenarios quickly. Football performance, therefore, starts with mental and cognitive underpinnings and manifests itself through skills and physicality and under numerous pressures, including the pressure of the audience, the clock, and other factors, all of this continuing throughout the performance period (7). The player must maintain constant focus throughout the long playing session due to ongoing mental pressure. The player's performance strategy depends on continual adjustments to the game's specifics. These inputs depend upon the player's mental condition for taxing situations (8).

According to the research, the most important kinetic skill in football is "shooting" (9). It is an important and decisive skill for scoring goals and achieving victories. It is a skill that can be performed in various ways, requiring a significant amount of practice to control the shot and achieve the necessary accuracy (10). The significance of direct free kicks is demonstrated here because it is a fundamental, decisive, and highly effective skill for scoring goals and resolving matches. Many world championships have been decided by direct free kicks, which have influenced the outcome of the competition. A team's distinction through direct free kicks undoubtedly gives them an advantage in winning matches (11). One of the most skillful forms of direct free kick shooting in football is the instep football kick, the main shooting skill when shooting direct free kicks from close, medium, and even long distances. The instep football kick is repeated throughout the playing period (10). It is performed with the malleolar part of the foot with accurate and sensitive guidance to the point of hitting the ball (11). This skillful performance is required of all football players because any player may be in a position to shoot the ball during the game (12).

The shooting skill depends upon the football kick. This type of kick requires strength, speed, and accuracy. This makes the kinematic performance model, which is based on performance variables. The performance variable is the figure which is obtained when the player performs the shot (13). These kinematic variables are based on joint angles, angular and linear velocities, distances, displacements, the pivot foot, and the accuracy values of direct free-kick shooting (10).

Several research studies have been conducted to investigate the impact of the mentally exhausted condition on athletic performance. Some studies have found that the mentally exhausted condition lowers athletic performance, while others have found contradicting results. Smith et al. (14) investigated the impact of mental tiredness on intermittent running performance. According to Van Cutsem et al. (15), mental tiredness does not affect maximal strength, power, or anaerobic work. Furthermore, Rahimizadeh et al. (16) discovered that despite the formation of exceptional skills, despite mental tiredness, particular characteristics stay robust and lead to the creation of extraordinary talents.

As a result, this study sought to ascertain the impact of mental fatigue on the accuracy of direct free kick correction with the instep football kick in terms of some kinematic characteristics for football players. The concept of skill performance is completely based on mental-physical performance, which is obtained by kinematic variables. Even though the topic of this study has been the focus of numerous studies (5, 17, 18), most of them sought to understand the impact of mental tiredness on specific physical or skill characteristics associated with sports performance. Few studies aimed at finding the effect of kinematic variables on the accuracy of the free kick in football (11, 12). There are many studies investigating the effect of muscle fatigue on some kinematic variables related to the skill performance of a player (19). The significance of this study is different from the previous one. This is related to the understanding of the impact of mental fatigue on the accuracy of direct free-kick shooting with the inner instep by analyzing several kinematic variables whose values are associated with shooting accuracy in football players. There is importance in the studies, which are mostly related to the mechanism and the physical activity of the player, but this study contributes to the specific action of the player. This action is responsible for the loss and the gain of the game and the player. This skill is responsible for the development of longitudinal and acute effects on the player's mind as well as the other population. This skill has an emotional connection with the mind; therefore, the positive impact of this skill requires a healthy mind instead of fatigued mental health. The circumstances and the factors related to mental fatigue health which is responsible for the accuracy of the shooting free kick have been investigated. This study is unique in this aspect and very helpful to provide information in this domain of research. This kind of research can be very beneficial for the health and the diagnosis purpose of the player. This study is related to

free kick shooting and many other specific actions of many other sports that can add good literature.

3. Methods

This study was designed according to empirical research, where field and mental experiments were applied to achieve the objectives of this study. A sample of (n = 24) players from the Jordanian Professional Football League for the year 2022 who were specialists in shooting free kicks in their clubs and which all preferred using their right foot, were recruited. The inclusion criteria of the study are the recruitment of football players who have experience playing in the league and are using the right foot. The physically unfit or the players near retirement were not selected for the study. Informed consent from participants was taken before the enrolment, and the study was approved by the institutional ethical committee. The demographic details of players have been presented in Table 1. Table 1 represents the details of average age, height, weight, foot mass, social-economic situation, and the number of experiences of the football league participants, respectively. The study supported the qualitative research approach (20). The finding of the study was completely based on the nature of the human experience and the responses to the health criteria (21). The average data of demographic details of the player have been collected in Table 1. The descriptive correlation research design was used in this study to describe the relationship between variables and replaced dependent and independent variables with predictors and criteria (20) while following the STROBE guidelines.

Table 1. Average Demographic Detail of Players

Variables	Mean ± SD
Age (y)	26.8 ± 2.1
Height (m)	1.78 ± 0.18
Weight (kg)	72.4 ± 4.1
Foot mass (kg)	9.9 ± 1.5
Annual income (Jordanian Dinar (JOD))	7500 ± 3500
Experience (y)	3 ± 15

3.1. Study Tests

3.1.1. Direct Free Kick Shooting Accuracy Test

The test explained by Bessenouci and Haceini (11) was used, as shown in Figure 1, where the player, after a good and appropriate warm-up, shoots the ball from a distance of 20 m toward the goal with legal dimensions (7.32 m × 2.44 m) divided into 15 equal squares. Each square had its points if the ball entered it. The points ranged from 8 points to one point. The player made 10 shots so that the highest mark for the test was 80 and the lowest was 0.

3.1.2. Mental Fatigue Test

The test explained by Kunrath et al. (17) was used, which is based on exposing the player to prolonged mental fatigue. In this study (17), the modified stroop methodology has been used to identify the purpose of mental fatigue for inducing players to prolonged mental effort. This modified methodology has been used to evaluate the peripheral perception of a football player. The assessment of the players strongly supports the usage of the instrument to minimize the mental fatigue of the players for their better performance.

In the beginning, four words (red, blue, green, and yellow) were displayed on the screen in front of the player at random for 1.5 seconds for each word. These words were displayed in different colors, for example, the word red was displayed in blue, and the player was required to specify the color of the displayed word, not the meaning. Things were reversed, and the player was required to specify the word's meaning, not the color in which it appeared. The test lasted thirty continuous minutes in prepared conditions without noise and in an appropriate atmosphere. The experiment was applied after encouraging the player to reach the best possible performance. Approximately 1250 items were shown to each player. The indicators on which the players have been working are subjective, physiological markers, and objective parameters. On a practical basis, there is variation in the tactical actions and the consequences, but this improves mental health and prolongs function (17). The activities related to cognitive tasks, including the utilization of constant usage of the smartphone, have reduced the negative impact on the brain and its mental health (22). Small stickers were placed on the joints (ankle, knee, pelvis, shoulder). A Canon EOS 80D camera was positioned on the side axis and perpendicular to the ballpoint, as it was 5.45 m away from the shooting location, and its lens height was 0.94 m. The second camera of the same type as the first one was positioned behind the ballpoint and perpendicular to it, as it was 6.23 m away and at the height of 0.88 m. After positioning the cameras in their places, a picture of a square measuring 1 m × 1 m was taken to check the scale ratio. All players performed the direct free kick test under camera footage, followed by a mental fatigue test after the player obtained sufficient rest. The direct free kick test was reconducted immediately after the mental fatigue and under-camera footage.

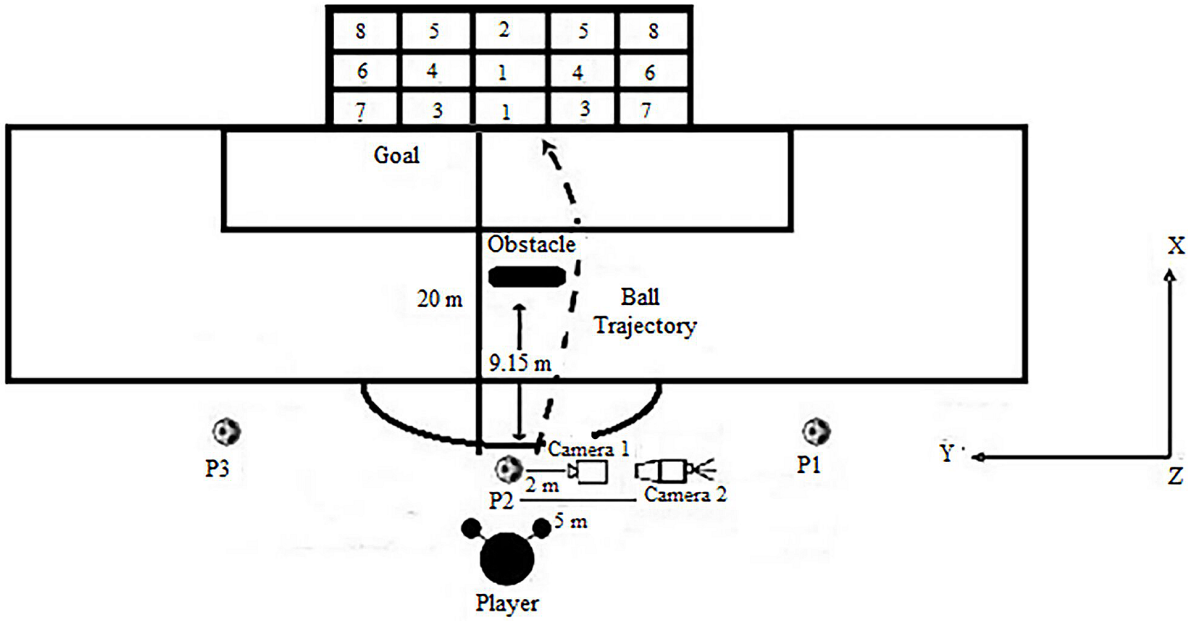

Figure 1. Direct free kick shooting accuracy test and data collection

3.1.3. Statistical Analysis

The descriptive data of the study was performed by means and standard deviation. Kinematic analysis was performed using Kinovea 0.9.5 software. A normality test was performed, and it was concluded that the behavior of the data of kinematic variables approximates the behavior of the moderation curve, and parametric tests were applied. Mean and standard deviation was calculated for quantitative variables. A *t*-test was applied to observe the mean difference between the two groups, and the P-value of < 0.05 was considered statistically significant. In Table 2, the kinematic variables consisting of speed, strength, torso angle, speed of the ball, knee angle in degree, knee angle in velocity, accuracy timing, pivot foot distance, and foot-to-ball distance were identified before the mental fatigue condition. In Table 3, the difference was identified between the mental fatigue players through Kinovea 0.9.5 software.

4. Results

A total of 24 players were recruited and analyzed. The demographic details of players have been presented in Table 1. Table 1 represents the details of the average age, height, weight, foot mass, social-economic situation, and the amount of experience spent in the football league of participants were 26.8 ± 2.1 y, 1.78 ± 0.18 m, 72.4 ± 4.1 kg, and 9.9 ± 1.5 kg, respectively. Descriptive statistical indicators of the kinematic variables before mental fatigue are presented in Table 2. The results of the *t*-test to estimate the significance of mental fatigue on the accuracy of a direct free kick in terms of some kinematic variables among football players are presented in Table 3. The mean difference in fatigue level of players before and after concerning the kinematic variables among football players was found to be statistically significant (P-value < 0.001). The kinematics analysis of the factors before mental fatigue and after mental fatigue represent that there was a significant difference. Mental health played a very important role in the players. According to Table 3, there was a significant decrease in the accuracy of the free-kick shooting player.

This lack of relationship between mental fatigue and healthy mental health cannot be explained mechanically since these two variables did not affect the accuracy as they were completely related. Still, it can be explained statistically that mental fatigue led to the absence of a contribution of these two variables to the shooting accuracy, i.e., the decrease in the shooting accuracy due to the exit of the torso angle variable and the variable duration of contact of the kicking foot with the ball from the partial kinematic model dealt with in the current study. This exit contributed to a defect in the skill performance, which ultimately led to a decrease in shooting accuracy due to the lack of the contribution of these two variables, in addition to the difference in the values of other variables before and after mus-

Table 2. Kinematic Variables Before Mental Fatigue

Kinematic Variables	Lowest Value	Highest Value	Arithmetic Mean	Standard Deviation	Skewness Coefficient	Kurtosis Coefficient
Speed of foot shooting ball (m/s)	0.206	0.224	0.214	0.006	0.00	-1.55
Ball speed (m/s)	28.100	28.420	28.208	0.065	1.26	3.75
Torso angle in degrees	251.400	257.000	254.042	1.497	0.39	-0.57
Knee angle in degrees	117.200	119.800	118.567	0.682	-0.35	-0.44
Knee angular velocity (°/s)	1326.800	1334.800	1330.525	2.903	0.25	-1.48
Pivot foot distance from the ball (cm)	7.140	7.840	7.235	0.139	2.84	7.08
Foot-to-ball contact time (s)	0.108	0.122	0.113	0.004	1.11	0.44
Accuracy out of 80	67.00	72.20	69.54	1.03	0.34	1.97

Table 3. Mean Difference in Mental Fatigue on the Accuracy of a Direct Free Kick in Terms of Kinematic Variables Among Soccer Players

Kinematic Variables	Before Fatigue		After Fatigue		Differential Testing	
	Arithmetic Mean	Standard Deviation	Arithmetic Mean	Standard Deviation	T-Value	P-Value
Foot-to-ball speed (m/s)	0.214	0.006	0.145	0.011	27.94	< 0.001
Ball speed (m/s)	28.208	0.065	16.757	1.119	50.46	< 0.001
Torso angle (°)	254.042	1.497	198.350	3.184	72.86	< 0.001
Knee angle (°)	118.567	0.682	145.158	6.683	19.91	< 0.001
Knee angular velocity (°/s)	1330.525	2.903	978.350	10.702	147.15	< 0.001
Pivot foot distance from the ball (cm)	7.235	0.139	5.888	0.166	36.40	< 0.001
Foot-to-ball contact duration (s)	0.113	0.004	0.275	0.031	25.47	< 0.001
Accuracy of 80	69.54	1.03	43.10	4.02	32.58	< 0.001

cle fatigue.

5. Discussion

The current study evaluated the impact of mental fatigue on the accuracy of direct free-kick shooting with the inner instep by analyzing several kinematic variables whose values are associated with shooting accuracy in football players. The results of the current study revealed the values of all the kinematic variables dealt with in the research. The value of the direct free kick shooting accuracy test for football players was affected by the variable of muscle fatigue and with statistically acceptable values, and this suggested that the mentally taxing performance burden has a detrimental impact on the skillful athletic performance of the direct free kick skill in football, as the accurate performance of this skill is the main achievement requirement for the player performing the direct free kick.

According to Tanaka et al. (22), the occurrence of mental fatigue is related to changes in some areas of the brain responsible for controlling movements and cerebral motor programming, as the different neurons in the motor cortex are affected by mental fatigue, which is reflected in the quality of its performance. Thus, the quality of the so-called dynamic coding of muscles regulates systole, diastole, periods of muscular work, and their optimal division (23, 24). In addition, the study by Smith et al. (25) demonstrated that mental fatigue decreased shooting accuracy in a football player sample. From another point of view, it can be said that the mechanics of the shooting skill with the inner foot of football players, which is based on the rotation of the torso and the foot shot at the ball, based on the pivot foot, the kinetic sequence, angles, and speeds of angles and time estimates stored in the players' kinetic memory are subject to weakness as a result of fatigue; as indicated by Rozand et al. (26). In our study, most kinematic variables remained related to accuracy after mental fatigue. These variables contributed to the decrease in shooting accuracy as a whole as a result of being affected by this mental fatigue. On the other hand, the results also showed two variables related to shooting accuracy: The torso angle and the

duration of contact of the kicking foot with the ball.

Thus, as a result, the null hypothesis, which stated that there was no significant difference, was rejected, and it was found that there was a statistically significant effect of mental fatigue on the direct free-kick shooting accuracy in terms of some kinematic variables among football players. According to Marcora et al. (27), mental exertion weariness can compromise physical function. As previously stated, mental fatigue is associated with a wide range of "side effects," including a lack of energy, increased fat and compassion, a decreased sense of motivation and alertness, and changes in perception and mood. As a result, it has been proposed that the consequences of mental fatigue may be twofold (28). The imposition of a cognitive burden on football players through the use of Strop software exercises and math examinations has probably damaged their energy levels. These effects have eclipsed physical performance and the ability to throw the third shot. The findings of this study contradict those of Smith et al. (14) and Rahimizadeh et al. (16). According to the results of this study, mental weariness does not affect peak performance or the performance of competitive athletes.

The fining of the study specifies that the manifestation of the player has a meaningful characteristic. Mental fatigue has a negative indication on both the players, the players appearing for the completion, and the players in training. As the players have a routine and specified timing with the training, their mental health requires good motivation, and they need the full concentration of life toward their physical load and pressure. The pressure of the training and the audience needs to be substituted with tactical and healthy programming. The software-based activities are also required to energize them on the aspect of close monitoring and developing focus. Training and media engagement is highly required for the capacity build of mind and body.

The limitation of the study is that it cannot implement the mental activation exercise based on software. The response collected by this study was manual on the base of feeling. The feeling and expression cannot be fully determined. There is no evidence of a modified Stroop methodology. The responses must be recorded for every player. The implementation of long training can develop stress conditions in the players with their routines. All these factors with the climate need to be monitored and preset with evidence.

5.1. Conclusions

The study's findings demonstrated that mental fatigue lowers a football player's ability to execute direct free kicks in terms of some kinematic variables, whether through the different numerical values of these variables or their lack of inclusion in the partial kinematic model of direct free kick ability when comparing mental fatigue before and after. For a player to continue to perform the skill required of him, regardless of mental issues that arise during football matches due to various circumstances, such as the constant pressure on the player to make the right decisions throughout the match and deal with the playing conditions and the coach's directives, especially tactical ones, it is strongly advised to develop programs that support the mental stability of the player during the matches. It is also recommended to study how football players' endurance levels or other talents are affected by mental tiredness.

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Footnotes

Authors' Contribution: This study was carried out solely by the corresponding author.

Conflict of Interests: The researcher confirms that there is no conflict of interests in this study with any participant

Ethical Approval: Approval for this study was obtained by the Medical Scientific Research Ethics Committee at the Faculty of Medicine, Mutah University, approval reference number (1092023). The author confirms that all procedures of this study comply with ethical guidelines. Participants were informed about the characteristics of the study and gave written informed consent.

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