Fatigue Impact to Mechanical Movement of Maximal Instep Kicking in Soccer

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Abstract. The fatigue factor can restrict and disrupt the player’s decision-making and also obstruct player’s cognition during the match. It is found that fatigue can decrease the speed of the ball while kicking after being trained (protocol fatigue training). Meanwhile, another finding comes out different that the speed of the ball doesn’t change significantly while playing in simulation match. The purpose of this study is to find out more comprehensively the level of fatigue to the change of movement’s mechanism that occurs in instep kicking technique. The method used in this study is quantitative descriptive. The independent variable consist of fatigue index levels (normal and maximum). Meanwhile, the dependent variables are the momentum of the ball, ground reaction force, and impulse. The result of the study shows that there is a significant difference in the speed of the ball between normal condition and fatigue. Furthermore, the result of Ground Reaction Force (GRF) and impulse shows significant difference.

1. Introduction

The quick and accurate kick toward the opponent’s goal is one of the weapon in scoring the goal. It is determined by the strength capacity, the strength of the leg muscle and the series of perfect movement mechanism. The series of that movement mechanism starts from linear speed and angular speed of leg swing, leg position during impact ball position, follow through position and upper body segment support in supporting the ball direction. Fatigue is a crucial problem which has long appeared from several scientific study in football games. According to [1,2], it can be considered as an obstacle to the achievement of athletes’ performance which will influence the process of sensory nerves continued to the process in the brain that will respond a movement error.

This negative influence can be seen from the decline of player’s movement ability which has impact to the maximal performance during the match. One of the causes of the issue appeared is because of abnormal physiological system of the body which influence the decline of strength muscular capacity. In addition, the fatigue also can restrict and disrupt player’s decision-making and also obstruct player’s cognition during the match. Based on some researches, fatigue also become one of the factors to the speed while kicking the ball.

The result of the research done by [3,4] found that the effect of the fatigue can decrease the speed of the ball significantly in instep kicking after protocol fatigue training by Running Aerobic Sprint Test/RAST. Meanwhile, there is a different finding by [5] that the speed of the ball doesn’t change significantly while playing in simulation match. According to [3] it explains the result of the study that fatigue doesn’t influence the average speed of the ball, but the maximum speed of the ball tends to decrease in the second half of simulation match. The decline of speed is on passing, shooting on goal
and long passing. Although the effect of the fatigue is connected with the study of biomechanical science and physiology in ability of kicking the ball, in fact that the problem is still unclear. From some researches related to fatigue with the kicking performance mentioned earlier, there are different implementations in the condition of normal player and one after the maximum fatigue. Those movements will effect the temporary fatigue or long period of accumulated lactate acid. According to [6] the theory and study in provision of treatment mechanism to the player as an effort to test the durability of cardiorespiratory and endurance of local muscle are different. It is caused in actual football match or practice, the movement volume of the player will be hard to predict in detail as it is done by [5] giving treatment with RAST protocol by doing 35m sprint for 6 repetitions and giving treatment strength training and muscle endurance by the weight.

![Figure 1. Back swing while maximal instep kicking in soccer](image1)

From the background description above, the problem of fatigue in kicking performance needs to be followed by a more comprehensive, scientific and actual research. Therefore, the theme that will be examined is related to mechanism of kicking movement which consist of basic technique of passing and shooting on goal linked to the fatigue levels which consist of normal, sub-maximum and maximum from the change of heart rate monitor.

![Figure 2. Vertical Ground Reaction Force on the foot during maximal instep kicking](image2)

As for determination of the fatigue level with endurance test of cardiorespiratory, it uses gas analysis technology with treadmill set and software. While for seeing the change of movement mechanism in kicking by using three dimensional analysis frame of Dias IV.
As for the purpose of this research is to know the changes of leg movement mechanism in maximum instep kicking before and after the fatigue.

2. Methods
The samples of this study were 10 male players in students’ club of soccer at sport science department who have technical ability in kicking with the height average of 167 cm and weight of 59.2 kg. The method which can be used in this research is descriptive quantitative. Meanwhile, the design of the research can be seen in the picture below.

![Figure 3. Design of Descriptive Quantitative](image)

Notes:
X = Fatigue levels (normal and maximum fatigue)
Y1 = Momentum of the Ball (kg / m / s)
Y2 = Ground Reaction Force (Newton)
Y3 = Mechanical Power (Watts)
Y4 = Impulse (Newton / second)

The instruments used in this research is measurement technology of gas analysis from Cosmed Pulmonary Testing, Italy. This tool is to measure player’s fatigue level with an indicator of pulse monitor.

| Zones | Type of Intensity | Pulse       |
|-------|-------------------|-------------|
| 1     | Low               | 120 – 150   |
| 2     | Medium            | 150 – 170   |
| 3     | High              | 170 – 185   |
| 4     | Maximum           | 185 <       |

Meanwhile, it uses Bushnell Radar Speed Gun to measure the speed of the ball. Then, to analysis kinematic kicking using three cameras (Panasonic; 4K Ultra HD Camcorder with wi-fi, built-in multi scene twin camera and electronic viewfinder for a semi-professional recording experience HC-WXF991K). The tools for measuring Ground Reaction Force are 3D Anti Force and motion Force Platform.
3. Result and Discussion

There were the results of the data ball velocity when the player under fatigue and normal condition.

![Figure 4. Scheme of Data Collection](image)

![Figure 5. Data ball velocity under fatigue and normal condition](image)

The results show that the speed of the ball from each player during normal conditions (47.6m/s) and fatigue (31.2m/s) there are significant differences. But there are some players who did not show any significant difference. This one is because the players have maximal level of aerobic capacity (VO2max) is high.
The results show that the ground reaction of each player during normal conditions (1765 N) and fatigue (1120 N) there were significant differences. On the other hand, there were some players who did not show any significant difference. This one is because the players have a great level of leg power.

The relationship between the speed of the ball and the ground reaction force foot support seen from figure 5 above. The result shows that there was a positive and significant relationship between ground reaction force and speed of the ball. This shows that the larger ground force reaction foot support then result in greater ball speed.
The data shows relationship between the speed of the ball with the leg swing velocity. The result shows that there was a positive and significant relationship between the swing leg speed and ball speed. This shows that the greater the speed of the swing leg result in greater ball speed.

4. CONCLUSION
The average speed of the ball when the players do not experience fatigue condition which means that (normal) is 47.6 m/s. While the condition of the players experience fatigue maximal ball speed is 31.2 m/s. The maximum speed of the ball is determined by the speed of the swing leg, leg power and leg cantilever strong during Instep kick kicking.

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