# EFFECT OF APPROACH SPEED ON SOCCER SHOOTING PERFORMANCE

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The purpose of this study was to investigate the effect of different initial conditions (approaching speeds) on soccer shooting performance (indicated by ankle speed at ball impact). Three initial conditions, including standing still, walking and running at self-selected speeds, were adopted for performing kicking. The results showed that the running condition, with the greatest approaching speed, led to the highest ankle speed for generating the fastest ball speed after impact. The current results will be used for building a mathematical model for simulating soccer shooting with various approach speeds.

**KEY WORDS:** coordination, soccer, initial condition, kicking

**INTRODUCTION:** Shooting is one of the main skills in soccer to score a goal. Previous studies in soccer/football have focused more on human body segments' angles, angular velocities, or balance ability to predict kicking performance such as passing or shooting a ball (Kellis, E., and Katis, A,2007 ; Nunome, H., Asai, T., Ikegami, Y., and Sakurai, S ,2002 ; Tracey, S. Y., Anderson, D. I., Hamel, K. A., Gorelick, M. L., Wallace, S. A., and Sidaway, B, 2012 ; Lees, A., Asai, T., Andersen, T. B., Nunome, H., & Sterzing, T ,2010). It appears that players prefer shooting with a running approach rather than from a static posture. For example, among the 171 goals in the 2014 FIFA world cup, only less than 10 of them were scored from a static initial posture (https://www.youtube.com/watch?v=CHw-Md2N_Jk). It has been shown that the velocity of the foot before impact directly affected the subsequent ball velocity (Andersen, T.,1999). Although a running approach resulted in a higher speed of ball than a stationary kick, it remains unclear whether initial running speeds affect the ball speed in shooting (Opavsky, P.,2011). The purpose of this study was therefore to compare the kicking performance using different initial approach speeds.

**METHODS:** Since the results of this study will be used for validating simulated soccer shooting movements rather than for comparing performance of different athletes, only one male participant (height 1.77 m; mass 64 kg) who was a university football team player with four years of experience was recruited. No lower extremity injury or pain within the last six months was reported. Two high-speed cameras (Basler AG, Basler pia640, Germany) with frame rate 200Hz were used. They were synchronized and calibrated for capturing movements mainly from supporting leg's implant to kicking leg's impact with the ball. Ten reflective markers were placed on both sides of the acromion process, greater trochanters, lateral knees, ankles and the fifth metatarsal-phalangeal joints. Joint linear and angular kinematics (ankle speed and hip speed) were analyzed by Kwon3D software. Shooting performance was determined by ankle speed rather than ball speed because the latter might be affected by impact point, spinning, and other factors which were difficult to control. Kicking the ball under three different initial approaching conditions, including 1. standing still, 2. walking and 3. running at self-selected speeds, were tested. Because the participant's dominant limb was right leg, motion analysis was performed only on the right side.

**RESULTS:** Movements of the kicking leg in soccer shooting have been defined to include three phases: back-swing, leg-cocking and leg-acceleration (Nunome, H. et al, 2002). The present study focused on the last phase (from maximum knee flexion to ball impact). Hip speeds at the beginning of phase 3 varied according to the approach speeds (Table 1). Horizontal and vertical ankle speeds during phase 3 for the three initial conditions were depicted (Figs. 1, 2 and 3). Since foot-ball impact might be performed with an angle rather

than straight forward, the horizontal speed (rather than separate forward or lateral speeds) was used. Positive vertical speeds indicated upward motion. It was found that, although horizontal ankle speeds at ball impact for initial conditions 1 and 2 were similar, ankle speed in condition 3 was more than twice the value in the other two initial conditions.

**Table 1**
**Hip speed under different initial conditions.**

| | Horizontal speed (m/s) | Vertical speed (m/s) |
|---|---|---|
| **Stand still** | 1.057948 | -0.3812 |
| **Walking** | 2.360465 | -0.7518 |
| **Running** | 3.501124 | -0.8432 |

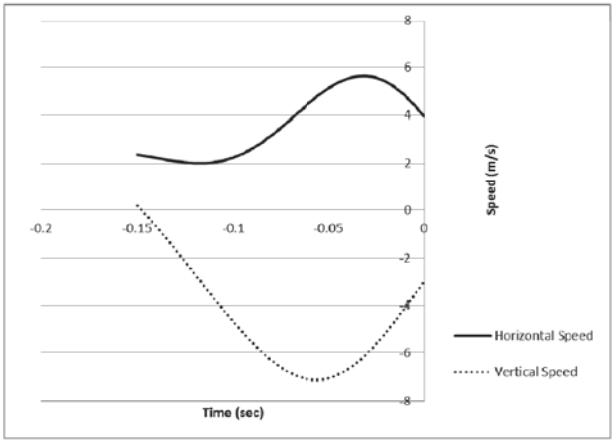


**Figure 1 : Ankle speed in phase 3 of soccer kicking under the stand still intial condtion (the 0 timing indicates ball impact).**

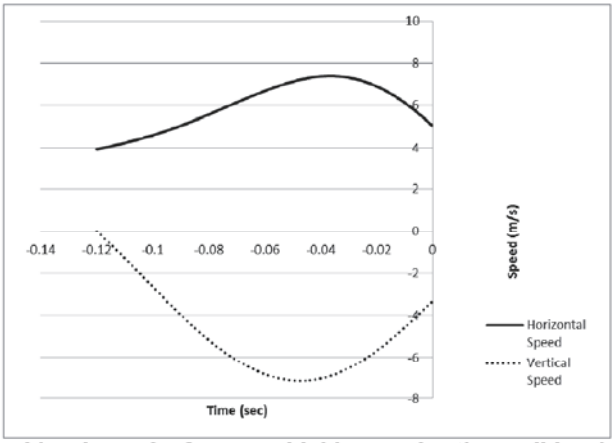


**Figure 2 : Ankle speed in phase 3 of soccer kicking under the walking initial condtion (the 0 timing indicates ball impact).**

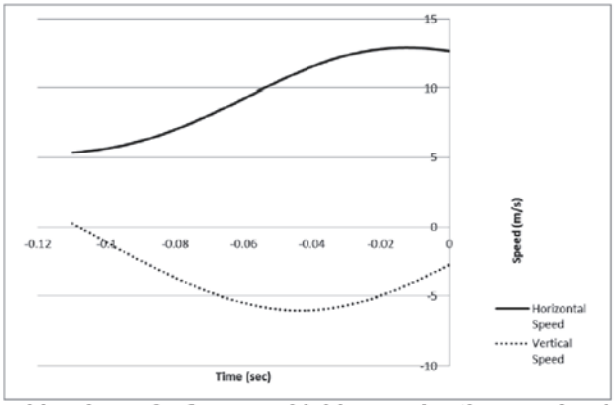


**Figure 3 : Ankle speed in phase 3 of soccer kicking under the running intial condtion (the 0 timing indicates ball impact).**

**DISCUSSION:** The purpose of this study was to investigate the effect of initial approach speed on soccer shooting performance. Although the accuracy of shooting is important for scoring, for simplicity only the horizontal ankle speed at ball impact was considered. It was therefore assumed that higher ankle speeds would result in higher ball speeds after impact. Moreover, the effect of different foot-ball impact locations (e.g. the sweet spot or other locations) was not considered either. With these simplified assumptions, it was found that kicking performance could be affected by initial approach speeds. That is, a greater initial speed (in the running approach) resulted in greater ankle speeds at kicking. However, whether ankle speeds increase with approach speeds or an optimal approach speed exists will require further investigation. For example, the current results will be used in mathematical modelling of a kicking motion with various approach speeds.

**CONCLUSION:** The initial condition (approach speed) was found to affect soccer shooting performance, or more specifically horizontal ankle speeds at ball impact. Further investigation with model simulation or data collection with more participants will be needed for determining an optimal approach speed in soccer shooting.

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