A THREE-DIMENSIONAL KINEMATIC COMPARISON OF KICKING TECHNIQUES BETWEEN MALE AND FEMALE SOCCER PLAYERS

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Kicking is a basic skill used in extensively the game of soccer. Isokawa and Lees (1988) as well as Luhtanen (1988) have investigated the soccer instep kick, with planar two-dimensional cinematography to determine the sequencing of lower body segments. It was found that the proximal segments initiate the movement, but then decrease their velocity as the more distal adjacent segments increase in angular velocity. The extent to which the segments interact and the timing patterns between segments for the soccer instep kick is not well understood. Browder. Tant, and Wilkerson (1991) and Tant (1990) have investigated the segmental interactions of a three-dimensional (3D) soccer instep kick for both male and female subjects.

The purpose of this investigation was to compare the kinematic parameters and temporal structures found between male and female intercollegiate soccer players during the soccer instep kick.

METHODOLOGY

Eight male and 7 female Division I intercollegiate soccer players volunteered as subjects. Table 1 presents demographic data on the subjects of the study.

Table 1
Demographic Profile of the Subjects

	Male		Female	
Variable	M	SD	M	SD
Age (yrs)	20.7	1.1	20.1	1.5
Weight (kg)	72.2	3.0	61.1	2.8
Height (cm)	176.4	2.9	151.8	3.3

Detailed instrumentation and analysis methodology for this investigation has been reported previously (Browder, et al.. 1991 & Tant, 1990).

RESULTS AND DISCUSSION

During a kicking motion the performer attempts to develop high speed with accuracy at the free end of an open-link system. Independent t-tests were used to determine if the male and female soccer players differed significantly during the soccer instep kick motion. The resultant ball velocities (RBV) of the low drive and maximum distance kicks in addition to the total movement time (TTM) of all 3 kicks were found to be significantly different ($p < .05$) between males and females (see Table 2).

Table 2
Resultant Ball Velocities and Total Movement Time

	Low Drive (LD)		High Drive (HD)		Maximum Distance (MD)	
Variable	M	SD	M	SD	M	SD
MALE						
TTM (ms)	166.00	1.7	181.00	2.9	171.00	1.6
RBV (m/s)	21.17	2.3	14.14	4.0	21.15	4.4
FEMALE						
TTM	*152.00	2.3	*165.00	3.5	*158.00	2.7
RBV	*17.01	3.5	13.51	6.6	*16.17	2.8

(* $p < .05$ between male and female subjects)

Males exhibit significantly greater isokinetic torques produced by the hip flexors and knee extensors when tested on the Cybex II dynamometer which may account for the increased RBV.

Maximum angular velocity (MAV) of the hip during flexion/extension was slightly greater in females in all 3 kicks. The hip reached MAV approximately at maximum shank back position (110 ms females and 120 ms males). As the shank reversed direction and moved forward the thigh decreased in velocity. A consistent pattern of increased velocities was exhibited during knee extension between both groups. Males had significantly greater velocities of the shank at ball contact (31.93 m/s, 35.51 m/s, 36.10 m/s) for the LD, HD, MD kicks, respectively, when compared to 21.84 m/s (LD), 23.12 m/s (HD), and 25.5 m/s (MD) for the females. Another component of increased RBV for males would be the increased velocity of the shank.

During all 3 kicks very little delay occurred between the forward motion of the pelvis (PEL) and thigh (THI) for both groups. As the subjects began forward motion of

the kicking leg the PEL preceeded the THI by approximately 2-3 ms, the lower leg (LLG) continued to move backward. Greater &lays, 81.9 ms (LD), 75.6 ms (HD), and 80.6 ms (MD) occurred between the PEL and LLG in the males than 76.5 ms (LD), 72.1 ms (HD), and 77.5 ms (MD) for the females. Slightly greater delays were also found between the THI and LLG for the males possibly due to increased range of motion of these segments during the kicking motion.

Both groups spent a greater percentage of time during Phase 4 (maximum shank back to ball contact) of the total movement time. However, males tended to spend more time during maximum thigh back whereas females spent more time during the support foot heel strike phase. Similar results were obtained for males and females during the relative timing of the segments (see Figure 1). Females tended to spend a greater percentage of time with forward movement of the pelvis, whereas males used the thigh and shank during a greater time, again a factor of increased range of motion.

A large percentage of shared positive contribution (SPC) between segments indicates simultaneity and a low percentage would be more sequential (Hudson, 1986). As shown in Figure 2, a significant difference of overlap was found between males and females of all 3 kicks between THI and LLG. The males exhibited less overlap using a more sequential pattern and again verifying the concept of increased velocities at the end of an open link.

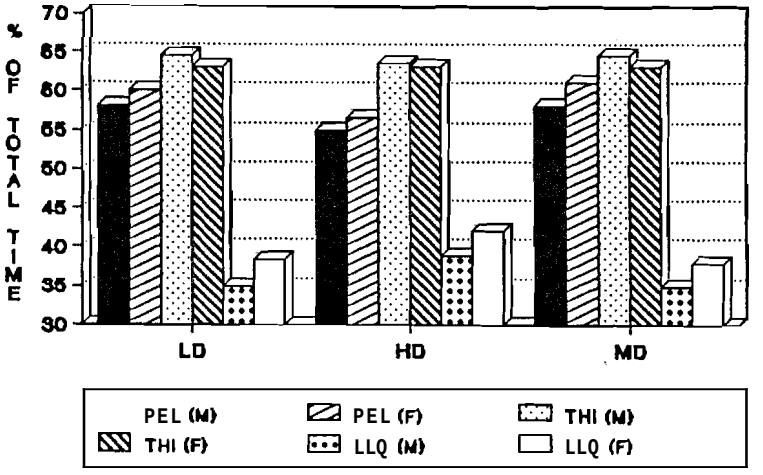

Figure 1. Relative timing **of segments**

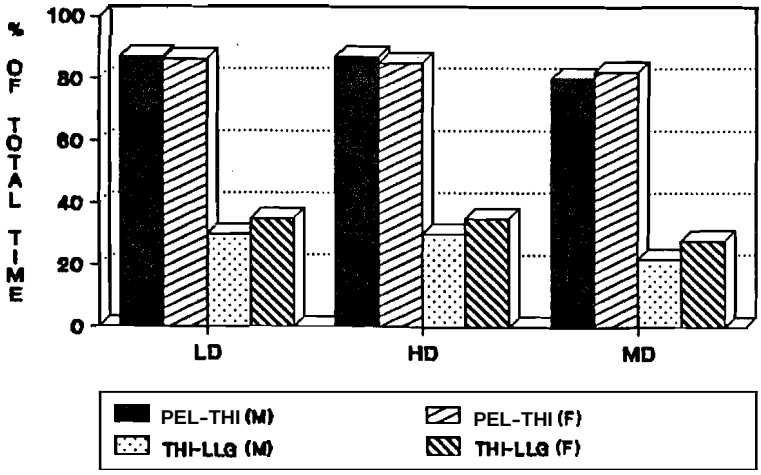

Figure 2. Shared positive contributions

CONCLUSIONS

Males had greater leg strength which produced increased RBV. In producing these velocities, males used greater ranges of motion at the hip and knee over longer time periods. Females exhibited greater pelvic rotation but tended to exhibit a greater inclination backwards of the trunk. The temporal structure seemed to indicate an invariant pattern between kicks and subjects.

For application to a coaching/teaching situation, the performer should kick the soccer ball with the same temporal pattern initiating the movement at the PEL, followed by the THI and LLG. Increased pelvic rotation with MAV at the knee should produce the greatest ball velocities. The contributions of the trunk and upper extremities should be investigated to determine their segmental contributions to the total kick. Increased leg strength. flexibility and a correct temporal structure should assist the performer in a successful soccer instep kick.

ACKNOWLEDGEMENT

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