

MECHANICAL EFFICIENCY OF DRIBBLING IN FIELD HOCKEY

Kimitaka NAKAZAWA and Hiroh YAMAMOTO

Biomechanics and Physical Education
Faculty of Education, Kanazawa University
Kanazawa, Japan 920

Keiko OHMURA

Togi machi
Ishikawa, Japan 920

Field hockey has its origin in 2050 B.C. at Athens in Greece. Despite its history, previous studies provided limited information on field hockey; Watson (1986) studied "boys' field hockey" from sociological aspects; on the other hand, Johnson et al. (1968), P. Bale et al. (1983), Withers et al. (1981), Steven et al. (1978) and Michael et al. (1976) studied physical ability of female field hockey players from physiological aspects. Lack of information has existed from scientific aspects, and especially biochemical analysis of specific skill in field hockey is needed. Therefore the purposes of this study are 1) to determine mechanical efficiency of dribbling a hockey ball as an index of skill, 2) to compare two types of dribbling from view points of energy economy.

METHOD

The subjects in this study were eighteen female hockey players who won the second championship at Japan National Highschool Athletics in 1985. Selected physical characteristic data are shown in Table 1.

TABLE 1
PHYSICAL CHARACTERISTICS OF THE SUBJECTS (N=18)

	Age (yrs)	Height (cm)	Weight (N) (kg)		Body density (g/ml)
Mean	16.5	156.0	506.3	51.7	1.064
S.D.	1.01	4.65	45.65	4.66	0.0038

The subjects were divided into three groups according to their own dribbling movements patterns: A group subjects (n=8) dribbled the ball using both forehand and backhand (Twist dribble), B group subjects (n=9) dribbled the ball using forehand only (keep dribble) and C group subjects (n=1) was the only person who did not belong to the above two groups.

All subjects first attended the laboratory test for measurement of $\dot{V}O_{2\max}$ while cycling to exhaustion on a cycle ergometer. Secondly, the laboratory experiment involved dribbling a hockey ball for 4.0 minutes while running on a treadmill at speeds of 4.00, 6.00 and 8.00 km/h. The control condition involved running at these speeds without the ball. Expired gas was collected into Douglas bags for the last two minutes of the exercise duration, and analyzed using Scholander technique. Stride rate was counted for the fourth minute of exercise. Rating of perceived exertion was assessed immediately on terminating the 4.00 minute exercise bout by means of the Borg (1970) scale.

The energy expenditure was calculated from the $\dot{V}O_{2\max}$ required and respiratory quotient. Work accomplished was determined as the product of the subjects' body weight, stick mass and treadmill speed. And then mechanical efficiency was calculated from the following formula:

$$\text{Gross efficiency} = \frac{\text{Work accomplished}}{\text{Energy expended}} \times 100 (\%)$$

On the field a dribble test was performed to evaluate individual skill level: the subjects were tested ability to dribble the ball between markers in minimum possible time.

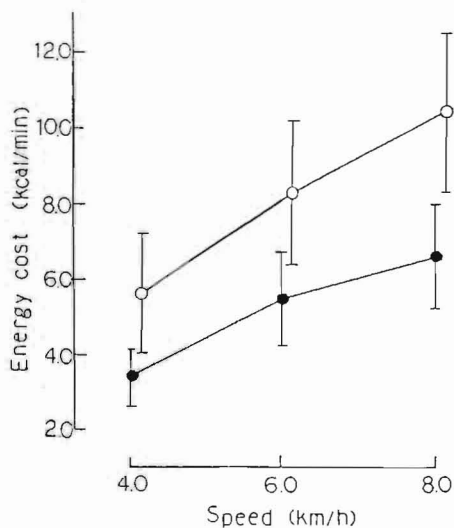


Figure 1. Energy cost (Mean \pm SD) for running (●) and dribbling (○) at three different speeds.

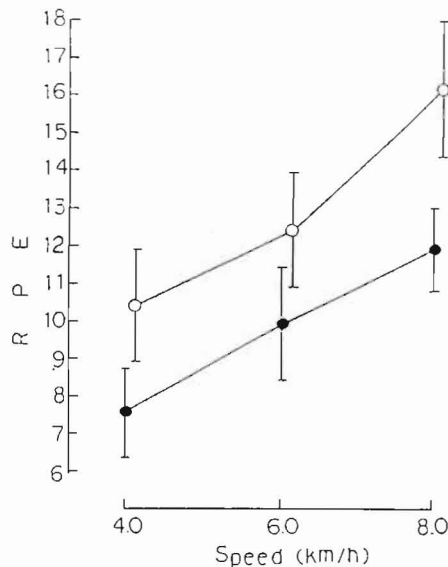


Figure 2. Perceived exertion (Mean \pm S.D.) of running (●) and dribbling (○) at three different

The $\dot{V}O_{2\max}$ of the subjects ranged from 32.09 ml·kg⁻¹·min⁻¹ to 55.35 ml·kg⁻¹·min⁻¹ with mean value of 42.8 (\pm 5.05) ml·kg⁻¹·min⁻¹. These values are relatively lower than those of Japanese National Woman Handball Team, 53.1 ml·kg⁻¹·min⁻¹ and higher than those of Japanese 18 yrs women, 40.7 ml·kg⁻¹·min⁻¹ reported by Kobayashi (1982).

Mean energy cost (\pm SD) for running and dribbling at three different speeds are shown in Figure 1. For both exercise modes energy cost increased

ACKNOWLEDGEMENTS: I would like to acknowledge the help of Mr. Takahiro Tobita, head coach of Isurugi H.S. women's field hockey team, and Mr. Yugi Hayashi, head coach of Isurugi H.S. men's field hockey team and all members of both teams, for consistent, professional and patient guidance throughout the process of our work.

with increments in speeds. The net excess cost of dribbling over running at the same speed did not vary significantly, but tended to increase with increments in speeds. This result did not agree with previous study about "net energy cost of dribbling a soccer ball" by Reilly and Ball (1984).

Average RPE (\pm SD) and stride frequency (\pm SD) at three different speeds are shown in Figure 2 and Figure 3, respectively. For RPE, the modes of exercise - running versus dribbling - as well as the speed showed significant result, on the other hand, for stride frequency only the speed showed significant result according to ANOVA.

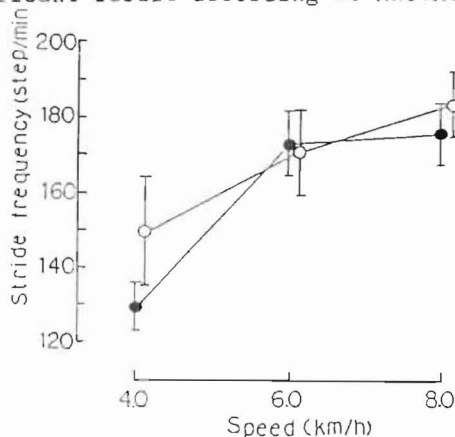


Figure 3. Stride frequency of running (●) and dribbling (○) at three different speeds. N=18.

Average T-scores of dribbling skill test were 54.3 ± 6.14 for A group and 47.8 ± 11.44 (Mean \pm SD) for B group. This result suggests that there may be differences of efficiency if the skill level (T-scores of the dribble test) are homogeneous in the two groups.

Correlations between mechanical efficiency of Twist dribble (A group) at a speed of 6 km/h and scores of the dribble test were found to be significant ($p < 0.01$), however, there were no significant correlations at other speeds. As for instep kick used in soccer, Asami et al. (1974) reported very high correlations ($r = 0.96$) between efficiency and accuracy of kick. Such relationship was not found in this study except the case of Twist dribble at a speed of 6 km/h.

On the basis of the results described it is concluded that there might be no differences of energy economy between Twist dribble and Keep dribble, and there might be existence of a certain speed (6 km/h) with significant correlations between mechanical efficiency and individual skill level.

Bale P. and P. McNaught-davis: The physiques, fitness and strength of top class women hockey players. *J. Sports Med.* 23, 80-88, 1983

Johnston, R. E. and Watson, J. M.: A comparison of the phenotypes of woman basketball and hockey players. *N. Z. J. Health P. E. Recr.*, 40:48-54, 1968

Michael G.M., E. Cannistra and D. Dublinski: Energy expenditure and Vo_{2max} of female athletes during treadmill exercise. *Research Quarterly*, 47-4: 692-697, 1976

Watson G.G.: A field experiment in sport socialisation and boys' field hockey. *J. Human movement studies*, 12, 1-26, 1986

Withers R.T. and R.G.D. Roberts: Physiological profiles of representative women softball, hockey and netball players. *Ergonomics*, 24-8: 538-591, 1981