MECHANICAL MODEL FOR DETERMINING BASE RUNNING SPEED OF SOFTBALL PLAYERS

Stephen Miller, Cynthia L. Tant, Michael Jocson, and Lynn Beasley

University of West Florida, Pensacola, FL. U.S.A.

INTRODUCTION

Whether running around the bases or running to catch a pop-fly, sprinting is a major concern for softball players. The goal of the softball player is to reach the bases or ball as fast as possible. The purpose of this study was to develop a model that would help the softball player increase speed during the sprinting action of base running. A model proposed by Hay and Reid (1988) (see Figure 1) served as the source for the development of a new model designed specifically for speed of a softball player. By manipulating the different mechanical factors and constraints involved with the model, the athletes would benefit and improve the times of their sprints.

According to Hay's model, the time and speed the athlete will obtain is dependent on two main things: Stride length (SL) and stride frequency (SF). SL is defined from heel contact of the right limb to subsequent heel contact on the right limb and is divided into three components: takeoff distance (TO), flight distance (FLT), and landing distance (LND). The TO and LND distances can be determined by the athletes' physique and body position. The FLT distance is dependent on velocity at takeoff, relative height at takeoff, and air resistance. By changing one or all of these factors the athlete is able to increase the speed and decrease the time in which the base is reached. When changing the SL of an athlete, SF can be changed. Initial increases in speed have been reported as a result of increased SL. After a stride of optimum length is attained, additional increases in speed must depend on increasing the SF (Adrian & Cooper, 1989). The SF is the number of strides an athlete takes with regard to the sum of the times during which the athlete is in contact with both the ground and in the air. If this time is changed then the time of the athlete's sprint will also change. Sprint times will decrease and running velocity increase by increasing the SL or SF or increasing both SL and SF.

In addition to the mechanical variables, identified by Hay, anthropometric, strength and flexibility factors have been shown to influence speed (Tittle & Wutscherk, 1992). Maximal muscular strength and power capacities represent essential elements for sprint speed. Explosive push-off and flexibility help determine SL. Leg length is associated with body height, the taller person usually has longer legs and should produce a longer stride. Because the athlete can manipulate many of these factors, the new model was designed to incorporate these variables.

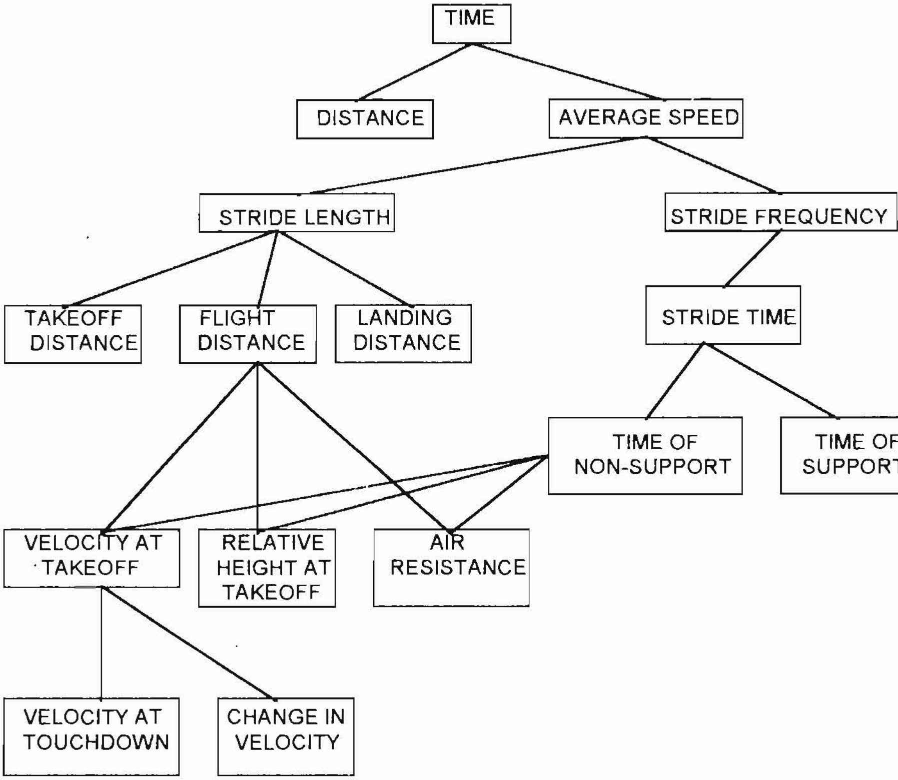

Figure 1. Deterministic model of running (Hay & Reid, 1993).

METHODS

Thirty-nine female softball players (age: 20.2 yrs ± 1.9; hgt: 165.1 cm. ± 7.9; wgt: 66.4 kg. ± 9.0) volunteered as subjects. Additional variables obtained included percent body fat (%BF), sit-ups/min.(SUP), 1 RM leg press (LPR), stationary 40 time (S40), flying 40 time (F40), and stride length(SL). The data, as shown in Table 1, represents the demographics of the population studied.

Table 1. Descriptive data of softball players

	AGE (yrs)	WGT (kg)	HGT (cm)	%BF	S&R (cm)	SUP (#/60s)	LPR (kg)
M	20.2	66.4	165.1	22.6	100.7	46.3	128.6
SD	1.9	9.0	7.9	4.2	12.6	7.6	23.6
SEM	0.3	1.4	1.3	0.7	2.0	1.2	3.8

The S40 (6.4 s ± 0.4), sprint time from standing to first 36.4 m (40 yds); F40 (5.7 s ± 0.5), sprint time between 36.4m (40 yds) and 72.8 m (80 yds); and SL (340.1 cm ± 30.0), distance between heel contact of right leg to subsequent heel contact of right leg, were used to verify Hay's model.

RESULTS

In an attempt to provide the athletes with variables, of which they could manipulate, the following factors were added to the SF aspect of the model (see Figure 2).

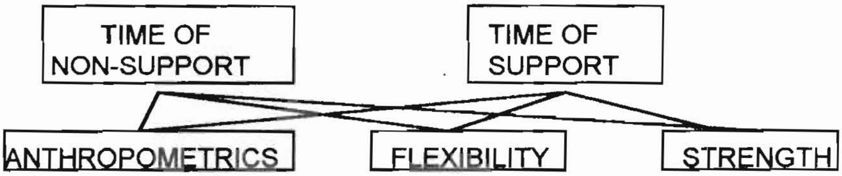

Figure 2. Additional stride frequency factors.

The physical characteristics of the athlete, anthropometric factors, would not be easily changed, however, each individual would have the ability to use their physique to the best advantage possible. A short-legged athlete would have to take more strides per unit of time then a long-legged athlete, whose stride should be longer.

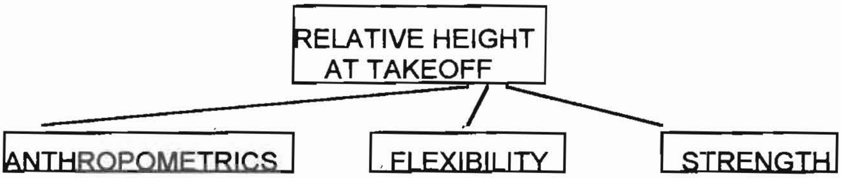

Figure 3. Additional stride length factors.

Through plyometrics, weight training and flexibility conditioning programs the athlete could effect the mechanical variables stated above. Resistance against gravitational forces, during the support phase, would be enhanced by a lower body conditioning program. To improve the speed of cycling, the time of non-support, assistance running and speed endurance activities should be planned. A plyometric program should assist in improvement of recruiting and firing potential of the lower body musculature for power. Increased flexibility would permit greater range of motion for increased flexion and extension of the lower body joints.

CONCLUSIONS

As the athlete manipulates the conditioning variables to change the force production characteristics, changes in the kinematic factors will occur. Decreased times during base running will increase the success of the athlete. To validate the proposed changes, kinematic data were collected, analyzed, and reported in Beasley, Tant, Miller, and Jocson (in press).

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