FACTORS CONTRIBUTING TO SOFTBALL PLAYERS BASE RUNNING SPEED

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INTRODUCTION

Sprinting actions are ballistic cycling movements. The fast-pitch softball player relies on the sprinting action to reach a base successfully. To produce maximum speed, proper execution of mechanical variables must be coordinated between the legs, arms and trunk. With increasing velocity, an increase in both stride length (SL) and stride frequency (SF) has been reported by Luhtanen and Komi (1973). A runner initially increases their velocity by increasing SL but will eventually increase SF to run faster. The purpose of this study was to determine which variables contributed to the success of a player on the base paths. In addition, to determine if the specific variables, defined in the model presented by Miller, Tant, Jocson, and Beasley (in press), were appropriate for determining speed.

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. Subjects were videotaped (60 Hz) in the sagittal view running from home plate to first base. The video images were captured, digitized, transformed, and smoothed (digital filter at 10 Hz) with the Ariel Performance Analysis System (APAS, LaJolla, CA). Data were statistically analyzed with regression analysis to determine which of the variables may predict speed. To control for individuals reaction time variance, in a stationary position, the dependent variable selected was the flying 40 time (F40). The independent variables included two areas: 1) descriptive variables of weight, height, percent body fat (%BF), sit and reach (S&R), sit-ups (SUP), leg press (LPR), stationary 40 time (S40), stride length (SL); and 2) kinematic variables of center of gravity displacement x (COG X), trunk inclination (TR), cog linear velocity x during takeoff (TO), flight (FLT), and landing (LND), angular displacement at the hip (HP), knee (KN), and ankle (AK).

The descriptive data (see Table 1) were collected with standard protocols for anthropometric and strength testing procedures (Baumgartner & Jackson, 1995). The S40 sprint time began from a standing position to 36.4 m (40 yds), the F40 sprint time occurred between 36.4 m (40 yds) and 72.8 m (80 yds), and the SL was the distance measured between heel contact of right leg to subsequent heel contact of the right leg. Kinematic data were generated from the APAS system after data collection and analysis. Relative angles of the lower body were analyzed during the support and non-support phases. Absolute angles were analyzed for TR for both right and left sides of the body.

RESULTS

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 additional factors considered with statistical analyses.

The kinematic data, presented in Tables 2 and 3, represented one full stride from TO to LND. The range of motion (ROM) during the non-support phase was determined at the hip (HP), knee (KN) and ankle (AK) on both the right and left legs. This ROM during flight would assist in determining SF, with increase in angular displacements, the legs would rotate faster to increase SF. Approximately, 50% of the time was spent in both the support and non-support times of the stride.

Table 2. Linear displacements, velocities, and trunk inclination during the stride

	COG X (cm)	TR Right (°)	TR Left (°)	VEL-TO (m/s)	VEL-LND (m/s)
M	156.5	21.4	15.7	7.19	6.41
SD	32.9	7.5	6.8	1.6	1.3
SEM	5.2	1.2	1.1	0.8	0.9

The slight differences noted between the right and left sides of the trunk were expected as the subjects displayed trunk rotation during the stride. Forward trunk lean of elite sprinters ranges between 5° to 7° (Mann, 1982). The subjects in this study had a tendency to lean more forward, possibly as a reaction to trying to reach the base, as fast as possible. The linear velocity of cog in horizontal direction at takeoff (VEL-TO) was greater than landing (VEL-LND), which was expected because of the braking force needed upon foot plant.

Table 3. Angular displacements at the hip, knee, and ankle (°)

	RHP	RKN	RAK	LHP	LKN	LAK
M	34.7	101.9	38.5	41.1	101.4	36.6
SD	13.1	15.6	12.4	14.6	11.9	15.7
SEM	2.1	2.5	1.9	2.3	1.9	2.5

The angular displacements indicated similar range of motion between the right and left legs. The data were not similar to previously reported results (Adrian & Cooper, 1989). A difference in how the angles were measured may be the cause for the discrepancies noted. None of the angular displacement results seemed to affect the F40 times.

A Pearson Product Moment correlation of $r = .7354$, $p \leq 0.05$ indicated a strong relationship between the S40 and F40 times. Because of this relationship and the fact that the athlete will most likely begin the sprint from a stationary position at home plate or on the bases, either time could be used for prediction purposes. A regression analysis was performed between the F40 time and the descriptive variables. A $r = 0.8692$, $p \leq 0.05$ was found between the F40 and LPR. This strong relationship would indicate that lower body conditioning was important for speed. A second analysis with the kinematic variables revealed a $r = 0.7567$, $p \leq 0.05$ between the F40 and TO linear velocity. The relationship noted here would assist the athlete in producing maximum velocity at the point of takeoff, which may be enhanced with a plyometrics and assisted running program.

CONCLUSIONS

Velocity in running is determined by SL and SF and any variation in either of these affects the velocity of the run. In this study, the TO linear velocity and LPR contributed significantly to reduced times in the F40. The model proposed by Miller, Tant, Jocson, and Beasley (in press) identified strenth as one component the athlete could manipulate to increase velocity. Additional variables were not supported in the model which may lead to changes in the model and/or selection of different mechanical factors to study.

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