BIOMECHANICAL ANALYSIS OF THE U.S. JUNIOR NATIONAL GYMNASTICS TEAM PERFORMANCE OF TUCK, FULL TWISTING, AND LAYOUT DOUBLE BACK SOMERSAULTS

B. A. Munkasy and **S.** L. **Smith**
U.S. Olympic Training Center
Colorado **Springs,** CO **USA**

The purpose of this study was to **determine the** relationship between selected biomechanical variables describing gymnastic tumbling **performance** and a subjective score based upon gymnastic judging criteria. This was done under **non-competitive** conditions. A correlation analysis was performed of selected gymnastic tumbling **kinematic** variables with an elite level coach's evaluation of each **performance.** Specifically, an evaluation was made of the tuck. full twisting, and layout double back somersault floor exercise movements.

METHODOLOGY

Nineteen male **Junior National Oly**mpic Team gymnasts (Age: **15.82** ± 1.43 years, Height 1.60 ± 0.10 m, Mass: 53.12 ± 10.70 kg) were videotaped on a strip tumbling platform performing three **trials** each of **roundoff,** back handspring, tuck, and/or full twist, **and/or** layout double back somersault into a landing pit. The platform was a spring floor created using panels from the floor exercise performance **area.** To assist in the identification of anatomical landmarks each athlete's joints were marked with reflective tape. A high speed video camera (NAC **HSV-400) operating** at 200 Hz, positioned perpendicular **to** the direction of movement, recorded each tumbling pass. The field of view was limited to the back handspring exit, double back takeoff, and beginning flight phase. A numerical rating **based on** the International **Gymnastics Federation** (IGF) **code** of points was used to evaluate each performance immediately after each tumbling pass.

The video information was digitized on an IBMPC compatible computer using the automatic mode of the PEAK Motion Measurement System. This system **tracked the** reflective markers and therefore joint position. The points digitized were the check, chin-neck intersect, shoulder, elbow, **wrist, iliac crest,** hip, **knee, ankle,** heel, and **toe. Nineteen** tuck, ten **full** twisting, and six layout double back somersaults were digitized. Scgmcnt

mass and center of mass were predicted using Dempster (1955). A fourth order Butterworth digital filter with a cutoff frequency of 8 Hz was used to smooth the data. Values for touchdown and takeoff velocities and angles as well as pre-flight and touchdown durations were calculated. Pre-flight duration was defined as the time period from back handspring exit until back flip entrance. Touchdown duration was identified as the time period from back flip entrance to back flip takeoff. Data were analyzed using the SPSS-PC statistical package.

RESULTS AND DISCUSSION

For the tucked double back somersault, a significant correlation ($p < .01$) was found between the score and pre-flight duration. touchdown angle. horizontal velocity, and takeoff vertical velocity. For the other movements. only pre-flight duration with respect to the full twisting movement showed significance (see Table 1).

The results indicate that those parameters which are attributable to back handspring performance affect the evaluation of a tucked double back somersault. Lack of significant relationships may be attributed to the low number of subjects who performed the other two movements. The overall low correlation between the variables measured and score may be attributed to the fairly homogeneous group studied. These results suggest that the root of successful execution of a tucked double back somersault may lie in the exit of the preceding back handspring. This conclusion is in agreement with Bruggemann's (1987) remarks on the subject

Table 1. Correlation of Gymnastics Double Back Somersault Movements with Selected Biomechanical Variables.

	Tuck (n=57)	Full Twist (n = 30)	Layout (n = 18)
Preflight Duration	-0.57*	-0.48*	0.17
Touchdown Angle	-0.45*	-0.34	-0.21
Touchdown Horizontal Velocity	0.48*	0.43*	0.51
Touchdown Vertical Velocity	0.18	0.36	
Touchdown Duration	0.11	-0.10	-0.21
Takeoff Angle	-0.26	-0.04	-0.21
Takeoff Horizontal Velocity	-0.04	-0.13	-0.02
Takeoff Vertical Velocity	0.79*	0.10	0.10

(* indicates $p < .01$)

CONCLUSION

Although these athletes were well beyond learning back handsprings, it appeared that concentration on back handspring technique as it relates to double back flip performance would be valuable. The significance of this finding from an applied point of view is that coaches want to know what their athletes will have to do to successfully complete double and even triple back somersaults. Their emphasis is often on the takeoff and flight of the flips as opposed to its approach.

REFERENCE

Bruggeman, G.P. (1987). Biomechanics in gymnastics. In B. Van Gheluwe & J. Atha (Eds.), *Medicine and Sport Science* (pp. 142-176). Basil, Switzerland: Karger.