IMPORTANT KINEMATIC FACTORS FOR FEMALE VOLLEYBALL PLAYERS IN THE PERFORMANCE OF A SPIKE JUMP

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INTRODUCTION

Numerous researchers have investigated vertical jump mechanics and determinant factors of jump performance in the field of sport biomechanics (Vint & Hinrichs, 1996). These studies have concluded that segmental and whole body mechanical power were the best predictors for vertical jump performance (Argón-Vargas & Gross, 1997). However, few of them have examined a jump in the context of competition (e.g., volleyball spike jump). In addition, the analysis of a simple vertical jump may have limited pedagogical usefulness for young athletes in competitive settings.

From the perspective of a sport scientist, the most important goal of biomechanical analysis is the ability to offer constructive feedback to athletes (Dowling & Vamos, 1993). For example, while the maximum mechanical power of the center of mass (COM) at takeoff accounts for 86% of the variability in jump height, the researcher can do little with this information to improve the jump performance because it is a difficult variable to use as a diagnostic indicator (Dowling & Vamos, 1993).

Therefore, the purpose of this study was to identify the crucial kinematic factors that contribute to a successful volleyball spike jump from the onset of approach to the peak of the jump height. Specifically, we investigated the factors that can be used for pedagogical purposes.

METHODS

Fifty female volleyball players (mean body height = 1.72 ± 0.08 m; mean body mass = 64.5 ± 11.0 kg) were recruited from high school and college-level teams. All policies and procedures for the use of human subjects were followed and approved by the local Institutional Review Board.

Each subject was required to warm-up for at least 5 min by stretching all major muscle groups for jump performance and practicing several normal spike jumps in front of a net and camera (see Figure 1). All subjects performed 10 volleyball spike jumps.

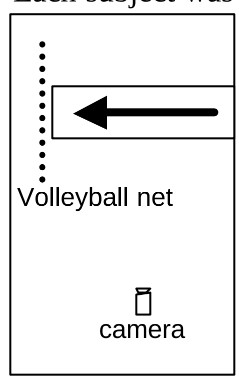

Figure 1. Experimental set-up showing one camera and volleyball net.

Two-dimensional coordinate data from one side of the body were obtained with a 60-Hz video camera in conjunction with a motion analysis system (Vicon-Peak). Data were collected from movement onset until after the peak of the jump. Coordinate data were filtered and then kinematic variables (see Table 1) were calculated to describe the volleyball spike jump performance. Various multiple regression model-selection methods were used to identify the most important variables for spike jump performance. The following methods were used: best subsets; stepwise; forward selection; and backward elimination techniques.

RESULTS AND DISCUSSION

Regression analysis identified six kinematic measures which accounted for 59% of the variability in spike jump height. In order of importance, these variables were *X10*, *X4*, *X8*, *X6*, *X1*, and *X5* as defined in Table 1. Table 2 shows the correlation of each variable with jump height. Moreover, the three best variables for predicting jump height were average angular velocities at hip, shoulder, and ankle joints during the arm swing and takeoff phases. These accounted for 51% of the variation in jump height and are shown schematically in Figure 2.

	r		r
*X10**	.6309	*X6*	-.1184
*X4**	.4923	*X1*	.0241
X8	-.0014	*X5*	-.2289

Table 2. Correlation coefficients of six variables from significant regression model. * ($p < 0.05$)

Surprisingly, the results drew attention to an unexpected finding which is that the average angular velocity of knee extension during the takeoff period was not a significant predictor for jump height. The volleyball spike jump may place different demands on the lower extremity musculature as compared to the much-studied, simple vertical jump. The importance of the arm swing is also recognized in these results.

Pedagogically, instructors, coaches, and trainers may want to focus on the speed of the hip, ankle, and shoulder joints during the performance of a volleyball spike jump. This contradicts present conventional instruction (e.g, Weishoff, 2002).

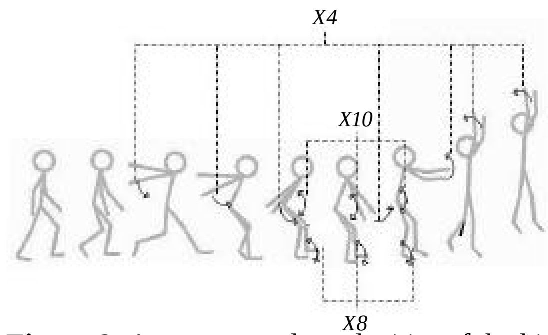

Figure 2. Average angular velocities of the hip (*X10*), shoulder (*X4*), ankle (*X8*) were best kinematic predictors of jump height.

REFERENCES

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Table 1: Kinematic variables in three phases of a volleyball spike jump

Phases	Approach	Arm Swing	Takeoff
Variable Name [Variable code]	Avg. Horizontal Velocity of CM *[X1]*	Max. Shoulder Joint Angle at Forward Swing *[X2]* Max. Shoulder Joint Angle at Backward Swing *[X3]* Avg. Shoulder Joint Angular Velocity *[X4]*	Max. Negative Vertical Velocity of CM *[X5]* Time of Downward motion of CM *[X6]* Time of Upward motion of CM *[X7]* Avg. Ankle Joint Angular Velocity *[X8]* Avg. Knee Joint Angular Velocity *[X9]* Avg. Hip Joint Angular Velocity *[X10]*