A KINEMATICS ANALYSIS OF HIGH SCHOOL CHAMPIONSHIP LONG JUMPERS

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INTRODUCTION: During regular observation of Amman high school meets, inconsistent long jumping techniques were noticed in the performance of those students who reached the semifinals and finals. This inconsistency in performance was large for athletes' trials and among competitors. In long jumping performance, biomechanics is a basis of technique. The kinematics of motion during the long jump could deteriorate if body segments are not regulated and are not well coordinated (Concelcao et al, 1996, Hyouny 1992). It is imperative to gather the phases of the jump in which coordination between various kinematics variables should be optimum (Al Kilani and Hashem, 1993). The center of gravity of the body (COFG) should be considered for biomechanical analyses. Thus, the path of COFG represents the body as a projected mass (Kilani, 1990). A projectiles law should then be applied to determine the maximum long jump distance achieved.
The height of (COFG), velocity of (COFG) and projection angle of (COFG) are the most theoretically important variables that determine the optimum horizontal distance jumped. However, more than these variables may contribute to long jumping, when a human being is involved as a projected mass. Hay (1993) explained the percent contribution of each phase in the long jump. In this study, it is important to know the extent to which the different variables contribute to long jumping performance at the level of high school athletes and to determine the common parameters that most contributed to their performance. Quantitative feedback can be given to coaches in order to help them correct their athletes' techniques. The purpose of this study was:

1) To investigate the selected kinematics variables in the long jump for high school athletes in Amman;
2) To determine the significant differences between the actual distance and legal distance achieved;
3) To discover which kinematics variables contributed the most in long jumping performance during the Amman high school championship, and
4) To learn about the technical errors athletes committed and to compare them with the available optimum models in the long jump;

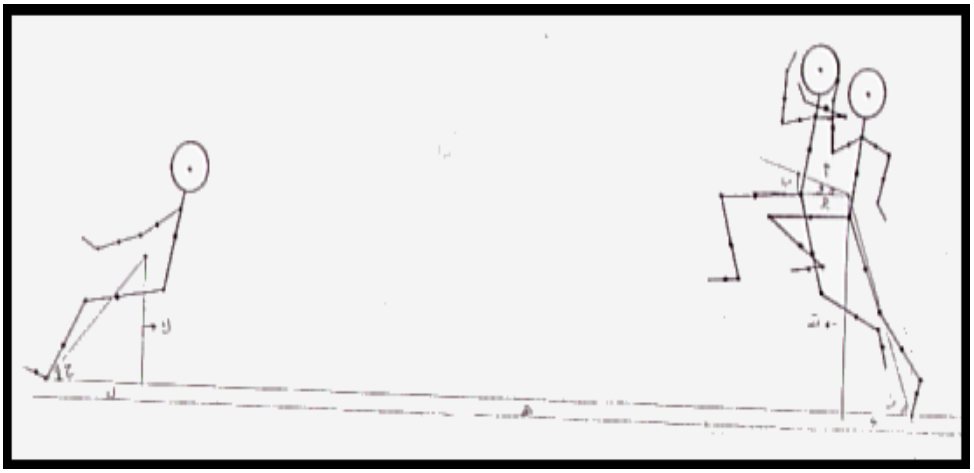
The questions were as follows:

1) What are the values of selected kinematics variables in the study?
2) Are there significant differences between actual distance and legal measured distance?
3) What are the kinematics variables that most contributed to the horizontal distance achieved?

METHODS: Subjects: The best 15 high school athletes were chosen for analyses during the Amman high school championship. The total number of participants was 62 athletes representing 31 schools.

Apparatus: A Sony video camera with 50 Hz/sec was set perpendicular to the sagittal plane of motion which covers the distance from the take-off to the landing pit.
A video and (TV27) Sony were used for analyses. Transparencies with engineering tools were used for graphs and stick figures.
Procedures: Each subject had to put a phosphorescent mark on his right joints (shoulder, elbow, hip, knee, ankle and toe). Filming was conducted during the regular call of the ranked trials with the cooperation of the general judge of the meet. Three trials for each subject were filmed, but the best trial was considered for analyses. The following variables were calculated from the video film:

Flying angle (FA), take-off angle (TOA), landing angle (LA), vertical flying velocity (VFV), horizontal flying velocity (HFV), flying velocity (FV), height of the body center of gravity at take-off (HCGTO), and at landing (HCGL), take-off distance (TOD), flying distance (FD), landing distance (LD), actual distance (AD), legal distance judged (LED), and direct distance of the last three strides from the approach (DDLS). Figure (1) Means, standard deviations and the ranges of the kinematics variables are shown in table (1).



FV	VFV	HFV	TOD	FD
TOA	LA	HCGTO	HCGL	LD

RESULTS: Data were statistically processed with the SAS program, where correlation techniques with stepwise regression and T test were used.
(Tables 3, 4 and 5).

TABLE 1: Mean standard deviation and range of the kinematics variables used in the study.

Range		**SD**	**Mean**	**Kinematics Variables**
Max	**Min**			
8.5 m/s	6.2 m/s	0.72	7.6 M/S	HFV
3.1 m/s	1.2 m/s	0.53	2.00 M/S	VFV
8.6 m/s	6.3 m/s	0.74	7.8 M/S	FV
72 °	60 °	3.54	65 °	TOA
76 °	42 °	10.12	53 °	LA
21 °	7 °	14.8	15 °	FA
45CM	0CM	13.46	21CM	TOD
112CM	85CM	6.11	99CM	HCGTO
84CM	47CM	8.71	63CM	HCGL
57CM	37CM	5.76	46CM	TOD
331CM	487CM	57.82	413CM	FD
68CM	14CM	14.82	47CM	LD
579CM	410CM	54.84	506CM	AD
564CM	376CM	57.49	485CM	LED

TABLE 2: A simple correlation between selected kinematics variables in the study.

7	6	5	4	3	2	1	No.	Variables
0.373	-0.042	-0.224	0.335	-0.245	0.143		1	FV
0.625	0.062	0.109	0.114	0.425			2	FA
0.354	0.082	0.669*	-0.296				3	TOD
0.036-	0.242	-.0131					4	LA
0.353	0.115						5	HCGTO
-0.07							6	HCGL
							7	AD

* α < 0.05
N = 7.

TABLE 3: Percent contribution of the individual kinematics variables.

PERCENT CONTRIBUTION	KINEMATICS VARIABLE	NO
0.39	FA	1
0.14	FV	2
0.13	TOA	3
0.12	HCGTO	4
0.005	HCGL	5
0.001	LA	6

TABLE 4: Percent contribution of the two-kinematics variables.

PERCENT CONTRIBUTION	KINEMATICS VARIABLES	NO.
0.47	FA + FV	1
0.47	FA + HCGTO	2
0.40	FA + HCGL	3

TABLE 5: Percent contribution of three kinematics variables.

PERCENT CONTRIBUTION	KINEMATICS VARIABLES	NO.
0.61	FV + FA + HCGTO	1
0.52	FV + FA + TOA	2
0.49	FA + HCGTO + HCGL	3

CONCLUSION:

1. There was a loss of 21 cm distance because the athletes' take-off occurred before reaching the take-off board.

2.The projectile lows match the outcome of these analyses as the most important three variables. These are the FV, HCGTO AND FA.

3. The FA was the most important kinematics variable in contributing to the actual distance jumped.

Horizontal velocity and vertical velocity of take-off must be optimal and match those ratios found in the literature.

4. The increased distance of TOD came at the expense of a decrease in the distance of FD which affected the total achieved distances jumped in the long jump.

Suggestion: It is important to practice bridging the gap between the running approach and take-off accuracy and to increase the HCGTO for most of the jumpers in the study.

REFERENCES:

Al-Kilani, M., Kilani, H. (1993). Optimisation of Triple Jump Performance: A Simple Model. *Dirasat. Proceedings of The Second Conference on Physical Education*. Part One. Amman: University of Jordan **7**.

Conceição, F., Gabriel, R., Vilas Boas, J., Abrantes, J. (1996). Kinematical and Dynamical Analysis of Long Jump Take off. A Four Cases Study. In J. Abrantes (Ed.), *Proceedings of the XIV International Symposium on Biomechanics in Sports* (p. 393). Lisboa: Edições FMH.

Hay, J. G. (1993). The Biomechanics of Sports Techniques. Fourth Edition (pp. 424-430). Englewood Cliffs, N.J.: Prentice Hall.

Hyoung, K. (1992). Three-Dimensional Analysis of the Flight Phase in the Long Jump. Abstract. Chicago: University of Illinois.

Kilani, H. (1990). A Periodic Analysis of an Elite Female Triple Jumper. In A. Al-Yarmouk, *Humanities And Social Sciences Series.* **1**(6). Yarmouk University.