EVALUATION OF AN EXERCISE PROGRAM BASED ON SELECTED SPEED AND STRENGTH CHARACTERISTICS IN ELITE FEMALE VOLLEYBALL ATHLETES

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INTRODUCTION

In any sport, exercise programs aim at improving performance by augmenting the general physical abilities and technique of athletes. Although various aspects of these performance factors may be interrelated and therefore an overall improvement in general physical abilities and technique is beneficial, identification of aspects most crucial to successful performance of a specific sport/activity would be valuable. Furthermore, an exercise program aimed at positively modifying factors deemed crucial to performance would be more effective than ones aiming at an "overall" increase in an athletes physical abilities and technique. In volleyball, one of the most important factors for success is vertical jumping ability-- a complex movement depending on both strength and speed of the athlete. It was, thus, the purpose of this study to: a) identify the strength and/or speed variables that determine vertical jumping ability and b) evaluate the effectiveness of a training program attempting to modify these variables.

METHODS

Two months prior to the commencement of the Greek national volleyball championship tournament, sixteen highly skilled female volleyball athletes, equally divided into control (age: 20.37 yrs; weight: 65.6 Kg; height: 1.79 m) and experimental (age: 20.42 yrs; weight: 67.3 Kg; height: 1.81 m) groups, were tested for: a) maximum knee joint extension isometric strength (Fmax--knee and hip joints at 90 degrees), b) countermovement vertical jump with (CMJ1) and without (CMJ2) the use of the arms, c) vertical jump from a (hip, knee and ankle joint) flexed position (SJ) --without countermovement, and d) drop vertical jump (DJ)--dropping from a height of 40cm. Force data were collected at a sampling rate of 1000 Hz utilizing a 1-D dynamometer connected to a PC. The measurement error was ± 5 Nt. Since vertical jumping ability has been identified as an important factor for success in volleyball, regression analysis was conducted to identify the strength and/or speed variables that determine vertical jumping ability (CMJ1). Based on the identified variables, the experimental group participated in an 8 week training program which included exercises ("guided" weight training, vertical jumps with and without extra weight and plyometric vertical jumping) specifically designed to a) decrease the propulsive time in SJ, b) decrease the ratio between propulsive time and flight time in CMJ2, c) increase the Fmax during the first 60msec, and d) decrease the time to Fmax. The control group was informed of the pre-test results, but was not given specific training instructions. At the end of the 8 weeks, both groups were tested again as in the pretest session. T-tests between pre-and-post performances were

conducted to reveal the effect of the exercise program that included specific training instructions.

RESULTS

Results of the regression analysis (Table 1) revealed that the propulsive time in SJ (PTSJ), the ratio between propulsive time and flight time in countermovement vertical jump without the use of the arms (TRCMJ2), the Fmax during the first 60msec (Fmax60) and the time to Fmax60 (TFmax) were all significantly correlated to the countermovement vertical jump with the use of the arms (CMJ1).

Table 1 (n=16)
Significant Correlations with CMJ1

Variable	Mean	SD	*r*	*p*
PTSJ (sec)	0.390	0.07	-0.77	0.005
TRCMJ2 (ratio)	1.859	0.28	-0.57	0.008
Fmax60 (N)	373.27	75.1	0.55	0.008
Tfmax (sec)	1.553	0.53	-0.78	0.005

Table 2 presents descriptive statistics and t-scores between pre-and post-test results for the experimental group. The results show that variables related to strength and power (Fmax60 and TFmax) increased by 17 and 16 per cent, respectively. The ratio between propulsive time and flight time in TRCMJ2 decreased by 19 per cent. Smaller ratio indicates superior performance--the faster the athlete is the higher he/she jumps. An 11 per cent improvement (decrease) was also noted in PTSJ. Note, however, that although the change (improvement)

Table 2 (n=8)
Descriptive statistics and *t* scores for the experimental group

Variable	Pretest (M, SD)		Posttest (M, SD)		*t*	*p*
CMJ1 (cm)	28.40	1.40	34.60	1.40	2.86	0.004
PTSJ (sec)	0.389	0.08	0.350	0.06	2.08	0.037
TRCMJ2 (ratio)	1.868	0.26	1.508	0.29	2.59	0.006
Fmax60 (N)	362.28	83.1	446.36	72.2	2.47	0.008
TFmax (sec)	1.511	0.56	1.266	0.52	2.46	0.008

in the independent variables was between 11-19 per cent, the dependent variable (CMJ1) improved by 22 per cent. This means that additional variables other than the ones revealed by the regression analysis were employed by the athletes to improve vertical jumping height (Papadopoulos, 1990).

Results in Table 3 indicate that, without the specific training instructions that were given to the athletes of the experimental group, members of the control

Table 3 (n=8)
Descriptive statistics and *t* scores for the control group

Variable	Pretest (M, SD)		Posttest (M, SD)		*t*	*p*
CMJ1 (cm)	28.60	1.70	29.00	1.60	1.56	0.067
PTSJ (sec)	0.391	0.06	0.387	0.06	1.52	0.067
TRCMJ2 (ratio)	1.850	0.30	1.839	0.35	1.52	0.067
Fmax60 (N)	384.26	67.2	394.46	59.0	1.78	0.052
TFmax (sec)	1.594	0.49	1.560	0.47	1.66	0.056

group did not significantly improve vertical jumping ability nor the variables predicting vertical jumping height (CMJ1).

CONCLUSION

The results of the study indicate that an eight week exercise program designed to a) decrease the propulsive time in vertical jumps from a (hip, knee and ankle joint) flexed position (SJ), b) decrease the ratio between propulsive time and flight time in countermovement vertical jump without the use of the arms (CMJ2), c) increase Fmax during the first 60msec, and d) decrease the time to Fmax, significantly increased countermovement vertical jumps with the use of the arms (CMJ1) in elite female volleyball athletes. However, additional variables other than the ones revealed by the regression analysis may be employed by the athletes to improve vertical jumping height.

REFERENCES

Papadopoulos, C. (1990). Empirische Untersuchung zur Trainierbarkei ausgewahlter Technikmerkmale bei der Hurdenuberquerung. Doctoral Dissertation, DSHS Koln.