

## A METHOD OF ESTIMATING MUSCLE ACTUATION WORK DURING VERTICAL JUMPS BY MEASURING THE GROUND REACTION FORCE

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**KEY WORDS:** efficiency, the vertical jump, elastic-viscous model.

It is well recognized that efficiency is very important in various human movement in sports such as marathon, race walking, football, volleyball and other else. For calculating efficiency of the movement, treatment of utilization of elastic energy is often controversial. It is generally difficult to recognize how much work was executed by actual muscle activity. The purpose of this study was to estimate the work due to the actuating muscle activity during vertical jumps using human tissue's characteristics of elasticity and viscosity. Thirty-three collegiate female volleyball players (Height =  $168.8 \pm 5.7$  cm, Mass =  $61.7 \pm 5.0$  kg, Age =  $20.2 \pm 2.8$  years) were instructed to perform vertical jumps as high as possible on a force plate(KISTLER-9281B). Ground reaction forces were measured three dimensionally during the performance of those jumps. Instantaneous changes of vertical velocity and the displacement of the body's center of gravity were calculated by the ground reaction force. It was hypothesized that the ground reaction force is composed of the elasticity force and the actuating force. Then the actuating force is hypothesized to be composed of the viscosity force and the muscle activation force. An elastic-viscous model was constructed taking account of the ground reaction force, the velocity and the displacement of the body's center of gravity. The elasticity force, the viscosity force and the muscle activation force were extracted based on this elastic-viscous model with several assumptions of the body. The work estimated by the muscle activation force is called actuating work( $W_a$ ), and the work calculated by the ground reaction force is called external work( $W$ ). The ratio of actuating work to the external work,  $P_a = W_a/W$ , was  $0.601 \pm 0.049$ .(mean  $\pm$  S.D.). There was a significant correlation between the jumping height and the ratio,  $P_a$  ( $r = 0.68$ ,  $p < 0.01$ ). The results show that subjects who exerted larger muscle activation work with relatively less elastic energy utilization.