INTRODUCTION

Peak power and average power are essential components in assessing the performance of an athlete. In terms of evaluating sports performance, power is used to evaluate the effectiveness of strength training programs over time, evaluating an athlete’s aptitude towards a specific sport. A number of prediction equations [1-3] have been developed to estimate peak and average jump power from jump height. Studies have shown that each population may require a specific regression equation to ensure accuracy of prediction [4]. Hence the purpose of this study was to develop new regression equations for female athletes and to develop a regression equation for long jump power that can be used to assess athletic performance.

METHODS

Twenty female university soccer players (age, 19.3 ± 1.12 years; mean weight 61.30 ± 7.80 kg; and height 1.66 ± 0.07 m) agreed to participate in this study, which was approved by the institution’s human subject review board. Anthropometric measurements included body mass (BM), height, inter-anterior superior iliac spine (ASIS) distance, leg length, knee width, and ankle width. All limb measurements were taken from both limbs.

For the motion capture, an 8 camera VICON MX-T40S retro-reflective motion analysis system was used. This system was synchronized with two AMTI Optima force plates. The cameras acquired data at 100 Hz and the force platform at 2000 Hz. Sixteen skin-surface retro-reflective markers were placed with tape on the trunk and legs according to the protocol of the lower body Plug-in-Gait model (PiG) [5]. The kinematic and force plate data obtained were filtered using the Butterworth routine and processed using the VICON Nexus software that incorporated the PiG model to calculate pelvis center of mass (CoMP) location during each trial.

The jump techniques were demonstrated to each subject followed by one practice jump. All jumps were performed barefoot and no restrictions for hand position were enforced. Each subject performed 5 maximum effort trials where they stood on force platforms in such a way that each leg was placed on a separate plate. The vertical jump height (VJheight) was the difference between the standing pelvis CoMP height and the maximum height attained by the pelvis CoMP during the vertical jump. The long jump distance (LJdistance) was the minimum distance between the heel motion-capture markers during take-off and landing positions for both feet.
Power output of the subject was calculated as a product of force and velocity [6]. Force exerted by the subjects resulted in vertical ground reaction forces (VGRF) at the feet which are assumed to act at the CoMP. The VGRF is the vertical component of force platform output and CoMP vertical velocity (CoMPVV) is obtained from the result of the PiG model. The resulting equation is:

\[
\text{Vertical Jump Power (W)} = \text{VGRF (N)} \times \text{CoMPVV (m. s}^{-1})
\]  

\[\text{VJ}_{\text{pk}} = \text{VJ}_{\text{avg}} \times \text{LJ}_{\text{pk}} \times \text{LJ}_{\text{avg}} \times \text{VJP} \]

Figure 3: Power versus force and power versus velocity during vertical jump.

Instantaneous power was calculated throughout the jumping movement using Eqn.1 from the loading position to the landing position for all 5 trials. Peak \(\text{VJ}_{\text{pk}}\) was the highest instantaneous power output value achieved; average \(\text{VJP}\) was calculated by computing the area under the positive instantaneous power output curve achieved during the vertical jump.

Figure 4: Power versus force and power versus velocity during long jump.

Instantaneous power was calculated throughout the jumping movement using Eq.1 from the loading position to the landing position for all 5 trials. Peak \(\text{VJ}_{\text{pk}}\) was the highest instantaneous power output value achieved; average \(\text{VJP}\) was calculated by computing the area under the positive instantaneous power output curve achieved during the jumping movement using Eq. 2 from the loading position to the landing position for all 5 trials. Similarly long jump peak power (\(\text{LJ}_{\text{pk}}\)) and average power (\(\text{LJ}_{\text{avg}}\)) were calculated.

\[
\text{Vertical Jump Power (W)} = \text{VGRF (N)} \times \text{CoMPVV (m. s}^{-1}) + \text{AGR (N)} \times \text{CoMP (m. s}^{-1})
\]  

\[
\text{VJ}_{\text{pk}} (W) = -2259 + 36.49 \times \text{BM (kg)} + 6983 \times \text{VJ}_{\text{height}} (m)
\]

\[
\text{VJ}_{\text{avg}} (W) = -1831 - 1.753 \times \text{BM (kg)} + 7510 \times \text{VJ}_{\text{height}} (m)
\]

\[
\text{LJ}_{\text{pk}} (W) = -2722 + 47.03 \times \text{BM (kg)} + 1423 \times \text{LJ}_{\text{distance}} (m)
\]

\[
\text{LJ}_{\text{avg}} (W) = -1382 + 24.44 \times \text{BM (kg)} + 837.1 \times \text{LJ}_{\text{distance}} (m)
\]

RESULTS AND DISCUSSION

The purpose of this study was to develop more accurate regression equations to estimate power during long jump and vertical jump for a sport, gender and age specific group as shown below. Both regression models employed vertical jump height, jump distance and body mass (BM) as independent variables.

Over the course of an athlete’s career, they will most likely gain or lose weight which affects their jumping ability. By calculating the power from the jumps, the practitioner can better evaluate the athlete’s power production capability, allowing them to more effectively evaluate their strength training program. Also, the long jump and vertical jump can be more accurately compared as both units are in Watts and more closely related in nature.

REFERENCES