INTRODUCTION

Aim of the work was the development of a protocol to acquire and reconstruct the movement of long jump for analyzing the biomechanics of the technical action and proposing a set of exercises finalized to the improvement of athlete’s performance. The study focused on the variation and correlation between the main parameters that influence the jump distance such as run-up speed, take-off angle, trajectory of the athlete’s center of mass (CM) and take-off forces. All values are referred to Hay’s equation (1993) of the jump parabolic trajectory:

\[ d = \frac{v^2 \sin(2\theta)}{2g} \left[ 1 + \sqrt{1 + \frac{2gh}{v^2 \sin^2(\theta)}} \right]. \]

METHODS

A male 26 years old long jumper with a personal best performance of 7.93 m (Italian Champion in ‘98) and two female long jumpers respectively 25 years old (Italian Champion 2000 and 2002, P.B. 6.50 m) and 18 years old (P.B. 5.48 m) were recruited for the study. Each athlete volunteered to jump three times with his normal run-up distance with 31 anatomical markers symmetrically placed on the skin. The jump action was recorded with a motion capture system (SMART e-Motion, composed by 9 infra-red cameras) and a high-resolution video camera. In the second phase of the study a Bosco’s Force platform was introduced into the analysis volume to analyze the biomechanics of the Bosco’s test (commonly used to evaluate athlete’s stiffness, reactive and elastic forces) and to compare the output given by the two systems. A dedicated software was implemented to analyze kinematics and biomechanics of the movement. It allows to define a 3D reference on each body segment and to calculate the joints angles, velocity, position and trajectory of the CM during the jumping based on athlete’s anthropometrics. The program output can be a stick diagram of the jumping action (Figure 1). This function enable the comparison of limbs trajectories for a better biomechanical and technical evaluation.

RESULTS AND DISCUSSION

The relation between run-up speed and jump distance indicates a rate of improvement of 8 cm per 0.1 m/s increase in speed, in agreement to Bridgett et al. study. Comparing testers performances with the two best jump of the world realized by Powell and Lewis in the ’91 World Championship in Tokyo, it was observed that best results are obtained when the slope of linear regression on run-up speed vs. jump distance is about 1 (Figure 2). This means that elitejumpers are able to maintain their speed in the flight phase, whereas other athletes must improve their technical action, with a correct training session planned by the coach.

By an analysis of the three vector components of athlete’s CM velocity, it was possible to understand the biomechanics of the jump movement. During the run-up stage, the athlete increases his horizontal speed; in the last three steps a lowering of the CM can be recorded that allow to prepare the take-off thrust: this produces a noticeable reduction of horizontal and vertical velocity during the initial contact of the last stance phase before take-off. Subsequently, the athlete activates thigh and shank muscles to project himself in frontal-vertical direction, transferring a part of his horizontal velocity to the vertical component to elevate from the ground. In the flight phase the athlete, subject to the gravity reduces his speed and describe a parabolic motion. Take-off angle, run-up speed, take-off forces and jump distance were analyzed to determine the existing correlation and to calculate, by variations of the desired value in the Hay’s equation, the possible rate of improvement for each athlete: the coach then able to indicate the margins of improvement and to plan a specific set of exercises.

Further information are being collected as a dynamometric platform is being used to measure the take-off forces.

REFERENCES

Vorobiev A. et al., 1994 Dossier tecnico Universo Atletica, pp. 30-34.