INTRODUCTION

The predominant requirement for success in a large number of athletic skills is explosive power. For the lower body, this is perhaps exemplified by vertical jump. Vertical jump is a complex ballistic multijoint movement, where the musculature around hip, knee and ankle joint collectively operate to produce patterned movements.

The main aim of this work was to present and analyse kinetic data (peak values of net mechanical moments and powers at the hip, knee and ankle) of an homogeneous group of athletes (sprinters) while performing vertical jump exercises. In addition the inter subject and intra subject variability of the kinetic parameters cited above were examined. For this purpose a total of 400 jumps were recorded and analysed.

METHODS

Ten subject, mean age 21.4 years, mean weight 76.9 Kg, mean height 178.7 cm, were chosen for this study.

They were asked to perform two-legged vertical jumps, as high as possible, keeping one foot over a Kistler force platform, and the arms behind their back, in order to minimize the contribution of the upper part of the body to the vertical jump. They were first asked to warm up for about 20 minutes, then to jump 20 times keeping the right foot over the platform, 20 times keeping the left one on it. Between each jump they waited 40 seconds, stopping for five minutes every five jumps.

Kinematic data, concerning the spatial position of ten anatomical landmarks (5 per side), were recorded by means of an optoelectronic system, ELITE [Ferrigno Pedotti, 1985], with a sampling rate of 100 Hz.

Ground reaction forces were recorded by means of a force platform at the sampling rate of 500 Hz.

Using the data recorded by the ELITE system and by the Kistler force platform, and the anthropometric data, the moments and the powers exerted at the hip, at the knee and at the ankle during the pushing phase were computed, using a specially designed software.

Particular attention was paid to the phase of preparation to the jump, and the data computed after the jump were not considered.

RESULTS

The mean jump height ranged from 40.2 to 46.9 cm, with a mean value of 43.9 cm (sd 5.2).

Considering moments, the mean values (expressed in Nm) were 121.5 (sd 30.2), 157.6 (sd 48.7), 108.7 (sd 15.8) for hip, knee and ankle respectively. For powers the mean values (expressed in watts) were 423.0 (sd 115.4), 716.7 (sd 155.3), 668.8 (sd 176.5) for hip, knee and ankle respectively.

For each subject, the mean values of the maxima moment and power are presented in figure 1.
The relationships between jumping height and the maxima moments and powers are presented in table I, where are reported the correlation coefficients between the variables.

FIGURE 1. Mean values of the maxima of moments and the powers computed for hip, knee, ankle joint among all the trials of each athlete

<table>
<thead>
<tr>
<th></th>
<th>Height - Moments</th>
<th>Height - Powers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip</td>
<td>0.08</td>
<td>0.02</td>
</tr>
<tr>
<td>Knee</td>
<td>-0.16</td>
<td>0.38</td>
</tr>
<tr>
<td>Ankle</td>
<td>0.16</td>
<td>0.58</td>
</tr>
</tbody>
</table>

TABLE I. Correlation coefficients between jumping height and kinetic parameters

DISCUSSION
Despite intersubject similarities in performing vertical jumps, marked differences were observed in amplitude and time occurrence of peak moment and powers. These findings suggest that our athletes use their major muscle groups differently to perform a very similar movement pattern. Even in vertical jump, a distinctive feature of the human motor system seems to be exploited, namely the potential to execute the same motor task through different combinations of muscle forces or of motor equivalent actions.

The analysis of the relationships between jumping height and the kinetic parameters would suggest that improvement in performance was related to changes in the timing and sequencing of net joint torques rather than to the changes in magnitude of kinetic output.

REFERENCES