The relationship between jump height, isometric strength and force-velocity

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Introduction
How can differences in jump height between differently trained groups and gender be explained? Our interest in furthering that issue arose with findings of a high percentage of slow fibres in female dance college students (1), a group perceived to have a good jumping ability. Was this a misconception or could any factor compensate for the fact that the force-velocity curve of slow fibres is not associated with a more developed jumping ability? We have therefore studied the relationship between jump height, two-legged isometric strength and force-velocity curve in professional ballet dancers (D), physical education (PE) students, untrained (UT) and strength trained (ST) individuals as well as volleyball players (V).

Methods
Male and female subjects formed eight groups of five (mean age 25 yrs), and were measured for maximal isometric two-legged extension in a strain-gauge dynamometer, isokinetic knee extension in a Cybex isokinetic dynamometer at four different speeds of velocities and for jump height (Sargent’s jump). Statistical comparisons were made between the groups (Anova and Student’s t-test) and correlations were made between different variables. Results are presented as mean values and +/- 1 standard deviation.

Results
The jump height correlated significantly to two-legged maximal isometric strength (Nm x kg⁻¹) (r=0.724, p<0.01). Furthermore, jump height per unit of maximal isometric strength (MVC) was significantly related to the force-velocity curve (r=0.611, p<0.01), i.e. the more strength retained at concentric contractions of 180 °/s in comparison to maximal isometric levels, the more jump height per unit of isometric strength.

Gender differences in untrained subjects + PE students + dancers were observed in jump height (32 %, p<0.001) and two-legged isometric strength (32 %, p<0.001), whereas no differences were noted in jump height per unit of maximal isometric strength or in the shape of the force-velocity curve. When these four variables were compared between all female and male groups, respectively, no differences were observed between the female groups, whereas a significant difference in jump height (p<0.05) was noted between strength trained and untrained men, as well as in the force-velocity curve of the male dancers and the untrained men.

The jump height per unit of isometric strength was 1.2 (+/−0.2) in the dancers and 1.4 (+/−0.2) in the non-dancers (p<0.05). The remaining force levels at concentric contractions of 180 °/s compared to the maximal isometric levels were 54 (+/−3) % in the dancers and 65 (+/−9) % in the non-dancers (p<0.05). When the differences in jump height per unit of isometric strength were adjusted for by the variability in force velocity curve, no differences existed between the gender or between the different male and female groups, respectively. Furthermore, equal values were noted in dancers and non-dancers (see table 1).

Discussion/Conclusion
The main findings of this study is that the variability in jump height between gender and groups with clearly different training background could be explained to a great extent by the combination of the differences in both two-legged isometric strength and in force-velocity curves. Unexpected findings were that the female professional dancers did not jump higher than the untrained and PE students, as well as the differences in jump height per unit of isometric strength and in force-velocity between the dancers and non-dancers. However, the latter results are in line with the indications that dancers have a predominance of slow-twitch fibres.

References