Direct versus indirect measurement of power with jump tests in female volleyball

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Introduction
Power output is an essential factor for performance in many sports. The velocity of a movement is closely related to the force. Jump tests have been usually utilised to evaluate power output of lower extremities, but many times, only jump height is measured, and power output is estimated indirectly from it. The most utilised equations underestimate power output in sport populations, but in control subjects it is overestimated. In the literature, there are power values in jump tests on a force platform from 3216 ± 607 y 5355 ± 522 W, in men and from 2425 ± 372 y 3536 ± 631 W in women. In this way, there are few studies with populations of female volleyball players. The purposes of this study were, firstly, to evaluate power output of leg extensor muscles using jump tests on a force platform, in a club-level female volleyball team, and secondly, to compare the results obtained with those estimated by indirect methods, and discuss about the suitability of them.

Methods
Thirteen club-level female volleyball players participated in the study (body mass, 61.4±6.2 kg; height, 1.64±0.05 m; age, 20.9±3.3 years; fat free mass, 50.9±4.3 kg; means±SD). Anthropometric variables were measured, and jump performance was tested using a piezoelectric force platform (Quattro Jump, Kistler, Switzerland). The subjects carried out an Abalakov test (ABK), a jump with arm swing, a counter-movement jump (CMJ), with hands placed on the hips and a squat jump (SJ), with hands on the hips, with a previous knee angle of 90 degrees. Subjects were familiarised with the jump tests in a previous session. The variables analysed were: jump heights, peak vertical power (PP), average power (AP), and the values of force and velocity at the peak power. Using jump heights and subjects’ body mass, PP were estimated from the equations of Lewis [PP=4.91/2 · 9.8 · body mass (kg) · jump height1/2 (m)], Harman [PP=61.9 · jump height (m) + (36 · body mass (kg)) - 1822] and Sayers [PP CMJ= 51.9 · CMJ jump height (cm) + (48.9 · body mass (kg)) -2007]; [PP SJ= 60.7 · SJ jump height (cm) + (45.3 · body mass (kg)) – 2055].

Results
The subjects showed the greater PP in the ABK (3536±631 W), followed by SJ (2879±539 W) and CMJ (2856±554 W). However, the greatest jump height was recorded in ABK (0.391±0.082 m), followed by CMJ (0.322±0.070 m) and by SJ (0.255±0.058 m). The values of the correlation coefficients between PP measured on the force platform, and PP from equations ranged from r=0.89 to 0.96 (P <0.01). Force and velocity values at the PP were 1381.8±170.8 N and 2.35±0.22 m/s in CMJ, and 1383.3±188.1 N and 2.08±0.20 m/s in SJ, respectively. The greatest peak vertical forces were found in SJ, followed by ABK and CMJ, whereas the greatest velocity was found in ABK, followed by CMJ and SJ. Forces and velocities at the PP correlated with PP from r=0.68 to r=0.87 (P < 0.05). All of the power equations correlated between them (r=0.83-0.99, P < 0.001). The Lewis equation underestimated PP from 73.4 to 76.5% and AP from 48.5 to 53.5%. The Harman equation underestimated PP from 15.7 to 30.7%, but overestimated AP from 49.8 to 57.28%. The Sayers equation gave lower power values than the other equations, but closer to the actual values, obtained with the force platform.

Discussion/Conclusion
The values of power in jump tests are greater than those found in other tests. The greater values of PP found in SJ support the idea that a greater PP is not always associated with a higher jump height, assumption made by the three power equations. The utilization of a force platform allows to study the velocity at PP. This is very useful for training, because velocity can be increased keeping the same power output. The Lewis equation underestimated PP with similar values to those found in the literature. The Sayers equation gave similar values to those found directly, but could not distinguish the subjects who developed higher PP in a population with similar jump heights. All the equations in this study underestimated PP. Nonetheless, it has been reported that in non-sport populations, the Sayers equation would overestimate it. Therefore, this fact supports the idea that Sayers equation will either overestimate or underestimate PP depending on the population studied. The Sayers equation should be chosen if instruments for measuring power directly were not available. Further studies should develop equations adapted to different populations, in order to enhance the validity of the results.

References
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