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JOINT SPECIFIC MECHANICAL POWER DURING VERTICAL JUMPS OF ELITE BOBSLEIGH ATHLETES

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The purpose of the study was to quantify jumping mechanics of elite male bobsleigh athletes (N=10; 28±3 yrs; 193±5 cm; 99±8 kg) performing two different kinds of vertical jumps (squat and countermovement). Kinetics and kinematics were measured with two force platforms (one per leg, 1080 Hz) and eight high-speed infrared cameras sampled at 120 Hz. Detection of the joint specific mechanical power generation pattern between legs and across athletes was realized via inverse-dynamic calculation. The results show an average jumping height of about 50 cm, which is associated with average body mass of almost 100 kg. An average joint specific contribution of mechanical power generation during squad and countermovement jumps could be determined close to one third per joint (hip, knee, ankle).

KEY WORDS: bobsleigh, sprint running, push-phase

INTRODUCTION: In bobsleigh it is generally accepted that the push-phase has a significant effect on sled velocity and therefore the final race time (Leornardi et al. 1987, Morlock et al. 1989). During the push-phase, the athlete has to accelerate the sled to reach finally a velocity, which is quite comparable to normal track and field athletes (Morlock et al. 1989, Brüggemann et al. 1997). To control progress of athletic training, especially for the start and push performance, vertical jump as well as 30 m sprint testing is an established tool of bobsleigh coaches, due to a high correlation between these tasks. Therefore the aim of the current study was to detect a joint specific pattern of power generation using two vertical jump maneuvers, simulating two different kinds of muscle-tendon unit functionalities (concentric vs. eccentric/concentric).

METHODS: Kinetics and kinematics of ten male elite bobsleigh athletes (28±3 yrs; 193±5 cm; 99±8 kg) were measured using one force plate (Kistler, Wintherthur, Swiss, 1080 Hz) for each leg, and eight high-speed infrared cameras (Vicon, Oxford, UK, 120 Hz) during countermovement and squat jumps. The lower extremity was represented using a two-dimensional inverse-dynamic model regarding to Hof 1992 including four rigid bodies (pelvis, thigh, shank, foot). The mass of the individual segments was calculated using the data from Dempster 1959 and the moments of inertia of each segment were adapted from Zatsiorsky and Selujanov 1983 . Therefore, on each leg five spherical retro-reflective markers (∅ 14 mm) were positioned on the following anatomical landmarks: 5th metatarso-phalangeal joint, lateral aspect of the malleolus, lateral femoral condyle, trochanter major, posterior spina illiaca superior, representing the body segments mentioned above.
During the squat and countermovement jumps subjects were advised to wear their preferred athletic shoes and to keep their hands on their hips during the whole task. The best of three trials, regarding jumping height (CoM elevation), was considered for further analysis. Resting period between trials was 2-3 min. depending on the individual need of the athlete.

RESULTS AND DISCUSSION: The data in Figure 1 show a countermovement jump height of ten elite bobsleigh athletes of about 50 cm (red squares) with an associated average body mass of almost 100 kg (blue dots). Looking on the joint specific contribution of mechanical power generation it is conspicuous that always the right hip generates more mechanical power than the left, whereas power generation of the knee and ankle extensors did not show a systematic generation pattern. However, it seems that the differences in power generation between left and right ankle joint is less in comparison to the left vs. right differences at the knee and hip joint across all athletes.

The averaged contribution of power generation in countermovement jumping for the hip, knee and ankle joint was 25%, 36%, 39% for the left and 33.5%, 34%, 32.5% for the right leg, which is almost a 1/3 distribution. Unexpectedly, the squat jump performance showed quite similar results (left leg: 29%, 32%, 39%; right leg: 34%, 33.5%, 32.5%) in comparison to the countermovement jump, which is notably because of their different kinds of contraction behaviour (concentric versus eccentric/concentric).

In general, this 1/3 detection during power generation seems to be unusual for vertical jump manoeuvres considering the differences in muscle strength of the leg extensors. It can therefore be assumed that the detected power generation pattern of elite bobsleigh athletes is highly adapted to their very specific sprinting, pushing and athletic training and not based on the common distribution of muscular capacity within the lower extremities.

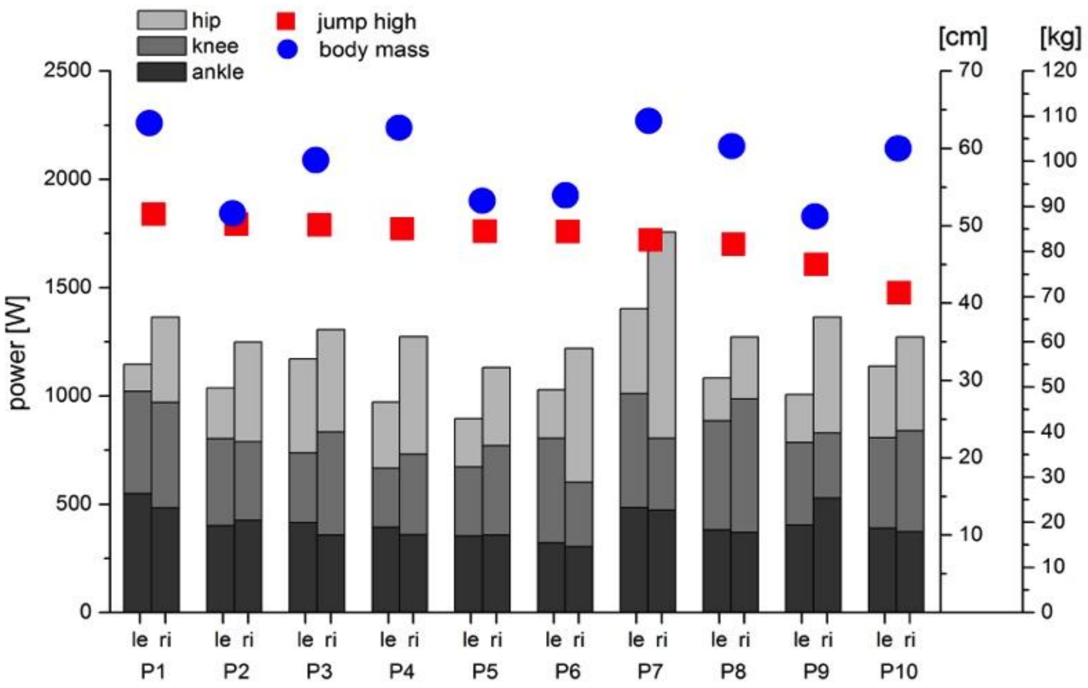

Figure 1: Joint specific (hip, knee, ankle) mechanical power, vertical jump height and body mass of ten elite bobsleigh athletes separately for the left (le) and right (ri) leg during countermovement jumps.

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