Comparison of Countermovement and Preferred-Style Jump Biomechanics in Male Basketball Players

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Abstract: The purpose of this study was to investigate and compare the biomechanics of countermovement (CMJ) and preferred-style (PrefJ) jumps. Eight male basketball players (age: 19 ± 1 year; height: 1.84 ± 0.14 m; mass: 92.8 ± 11.4 kg) participated in a cross-sectional study for which they performed max effort CMJ and PrefJ while motion capture and force plate data were recorded. The CMJ were performed according to common procedures. For the PrefJ, the eight players chose to use a short approach run and a step-in jump, with a clear lead and trail leg foot contact pattern. Vertical ground reaction forces (GRF), center-of-mass (COM) parameters, as well as hip, knee, and ankle flexion angles, extension velocities, net joint moments, powers, and work were all calculated and used for analysis. Bi-lateral data from the CMJ were averaged, whereas lead and trail leg data from the PrefJ were kept separated. The PrefJ was characterized by greater jump height and GRF and shorter contact times. Joint-level differences indicated that the PrefJ was characterized by larger joint kinetics. Importantly, very few biomechanical variables of the CMJ and PrefJ were correlated, which suggests that each jump type is characterized by unique movement strategies. Since PrefJ may better represent athlete- and sport-specific movement pattern, these findings could have implications for assessing and monitoring neuromuscular performance of basketball players.

Keywords: sports; biomechanics; performance; movement strategy

1. Introduction

The countermovement jump (CMJ) is often used to assess maximal neuromuscular performance of the lower body muscles [1,2]. Although CMJ jump height provides arguably the most direct measure of neuromuscular performance, researchers often expand CMJ performance analysis and examine a variety of additional variables from more advanced biomechanical technologies, which are thought to provide added insight about neuromuscular strategies during maximal effort CMJ [3–5]. For example, biomechanical studies often use force plate and motion capture data to calculate and investigate joint-level mechanics in relation to CMJ performance [6]. Some of these studies identified joint- or muscle-specific CMJ strategies that were useful for the exercise selection process for plyometric and resistance training sessions [7–9]. In addition, other studies identified subject-specific CMJ strategies, which in turn provided information about how athletes individualize joint-specific strategies in relation to CMJ performance [10,11]. Despite several positive qualities, the ecological validity of the CMJ in the context of neuromuscular assessment and monitoring is sometimes ignored in the scientific literature. This problem is perhaps best illustrated by the procedures that are used to administer...
the CMJ test, which is typically performed in a highly controlled laboratory setting with standardized procedures that constrain athletes into prescribed movement patterns [10,11]. For example, CMJ are often performed bi-laterally and with hands placed on the hips (i.e., without arm swing). While these constraints could in some instances be considered useful (e.g., isolating body neuromuscular performance), they may also inadvertently impose artificial constraints on athletes that limit them from using their preferred movement strategy (or solution) [12–14]. The pragmatic implications of such limitations are important in that CMJ performance etc. may not reflect an athlete’s neuromuscular capacities or movement strategies within the context of their sport [8].

Several researchers have studied biomechanical or performance differences between different types of vertical jump tests [15–19]. For example, Wagner and colleagues [18] compared jump performance and joint kinematics between volleyball spike jumps and CMJ and found that the jump heights of both types of jumps were correlated with each other. The authors suggested that spike jump performance is influenced by general jumping ability and the standard jumping tests could be a useful part of a volleyball-specific test battery [18]. In contrast, Requena et al. [17] found no correlations between jump performance of a soccer-specific jump and the CMJ, and therefore suggested that each test assesses different leg qualities and that practitioners should therefore be careful in using them to assess and monitor lower body performance [17]. Similarly, Miura et al. [15] and Pehar et al. [16] found that CMJ performance did correlate well with basketball specific jump performance and suggested that they represent different physical capacities. It should be noted, however, that none of these previous studies investigated differences or correlations in joint kinetics. It thus remains to be determined if differences in jump performance between various jump types also reflect differences in movement strategies.

The goal of the current study was to expand upon previous research into performance differences among different types of jumps with a special focus on investigating subject-preferred jump types in relation to standard CMJ and on elucidating the joint-kinetic contributions that differentiate between them. Therefore, the purpose of this study was to investigate and compare the biomechanics of CMJ and preferred-style (PrefJ) jumps in a group of male collegiate basketball players. We hypothesized that (1) athletes would jump higher and exhibit greater joint-level kinetics using PrefJ than CMJ, and that (2) PrefJ than CMJ would only exhibit partial similarities between jump height and joint-level kinetics. It was anticipated that similar to previous work [15–17], lack of correlations would illustrate that PrefJ not only assesses different leg qualities but also different movement strategies than CMJ, which would have implications for assessing and monitoring neuromuscular performance of basketball players.

2. Materials and Methods

Ten male basketball players (age: 19 ± 1 year; height: 1.84 ± 0.14 m; mass: 92.8 ± 11.4 kg) from the same National Collegiate Athletic Association Division I level team were recruited to participate in a cross-sectional study. Four of the recruited players were guards, five were forwards, and one was a center. All players signed an informed consent document, which was approved by Marquette University’s Institutional Review Board for human subjects testing.

Twenty-eight spherical markers were attached over several anatomical landmarks of the lower body and torso [8]. Once markers were attached, players performed a general warm-up that consisted of calisthenic exercises (e.g., squat and lunges) and several sub-maximal effort jumps. After the warm-up, each player performed a series of jumping tasks, which included three maximal effort CMJs and three maximal effort PrefJ during which each player could choose the approach and jump strategy. Players were given up to 30 s rest between each jump to minimize the effects of fatigue. The CMJ were performed with hands akimbo (i.e., placed on their hips with elbows pointed outwards). For the PrefJ, all but two players chose a jump strategy that consisted of a short approach run and a double leg take off with a lead and trail leg footfall pattern (Figure 1). The other two players chose
a single leg take off strategy. For the purposes of the current study only the players who used the double leg take off during PrefJ were included ($n = 8$).

During each type of jump, the positions of all markers were recorded with a 14-camera motion capture system (T-Series Cameras, Vicon, Denver, CO, USA) at 100 Hz. Ground reaction force (GRF) data were simultaneously recorded with two force plates (Models OR6-6, Advanced Mechanical Technologies Inc., Watertown, MA, USA) at 1000 Hz.

The marker and vertical GRF data were imported into OpenSim software (v3.3). The marker and GRF data were both smoothed with a 4th order low-pass Butterworth filter with a cut-off frequency of 12 Hz, which was determined based on a residual analysis. A musculoskeletal model that was specifically developed for movements with large flexion motions (e.g., squat, countermovement jump) was used in this study [20]. The model was scaled to each participant by adjusting anthropometric parameters (e.g., segment length and mass) within the model. Data were processed with a standard pipeline where joint angles were calculated with inverse kinematics (IK) and NJM were calculated with inverse dynamics (ID). The NJM were calculated as internal NJM and presented so that positive moments reflect extension moments at each joint. Joint angular velocities, net joint powers (NJP), and net joint work (NJW) were also calculated. All joint kinetic data were normalized by body mass of each participant. In addition, the vertical position and velocity of the pelvis segment were calculated and used to represent the vertical position and velocity of the COM.

Discrete peak variables were extracted from each jump trial. For the CMJ, peaks were extracted during the movement phase, which was defined as the time interval between when the summed vertical GRF fell below 95% of body weight and when both feet left the ground (i.e., summed vertical GRF $< 10$ N) (Figure 2). For the PrefJ, peaks were extracted during the ground contact phase, which was defined as the time interval between when the lead foot made contact with the first force plate and when both feet left the ground (i.e., summed vertical GRF $< 10$ N). Vertical jump height was calculated from the vertical velocity at the instant of take-off. The difference between vertical pelvis position at the beginning of each respective jump and at its minimum was used to represent the COM displacement during the lowering phase. The discrete peaks from each type of jump were averaged across trials to create within-subject averages, which were then used for statistical analysis. For the CMJ, data from the left and right leg were further averaged together into a bilateral average value. In contrast, for the PrefJ, data from the lead and trail legs were kept separate and considered as distinct observations.
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The independent variable in the current study was jump type (i.e., CMJ and PrefJ [lead leg, trail leg]). The dependent variables were whole-body biomechanical parameters (i.e., peak GRF, contact/movement times, COM velocities, jump height) and hip, knee, and ankle joint-level biomechanical parameters (i.e., angles, angular velocities, NJM, NJP, and NJW) (Figure 3). Assumptions of normality were checked with Shapiro-Wilk tests, which indicated that all the dependent variables exhibited a normal distribution. Given the directionality of the hypothesis, one-tailed paired t-tests and Hedge’s g effect sizes (with an adjustment for small sample sizes) were therefore used to investigate pair-wise statistical and practical differences between the bilateral average CMJ data and the individual averages of the lead and trail leg PrefJ data for all dependent variables. Pearson's correlation coefficients (r) were calculated to investigate selected associations between CMJ and PrefJ data (COM and joint-level kinetic parameters). The level of significance was set to $\alpha = 0.05$, which accounted for multiple comparisons (i.e., CMJ vs. PrefJ lead leg and CMJ vs. PrefJ trail leg) and the one-tailed directional hypothesis. The strengths of correlation coefficients were interpreted as weak (0.1–0.3), moderate (0.3–0.5), strong (0.5–1.0), and the effect size magnitudes were interpreted as small (0.20–0.49), moderate (0.50–0.79), or large ($\geq 0.80$).
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Figure 3. Ensemble average of the hip (left column), knee (middle column), and ankle (right column) joint angles (first row), joint angular velocities (second row), net joint moments (third row), and net joint powers (fourth row) during the countermovement jump (CMJ) and preferred-style jump (PrefJ).

3. Results

3.1. COM Parameters

The statistical analysis showed that the peak GRF were greater during the PrefJ than the CMJ (Table 1). The statistical analysis also showed that the ground contact times during the PrefJ were shorter than the movement times during the CMJ (Table 1). In addition, peak COM velocities and jump height were greater during the PrefJ than during the CMJ (Table 1). Lastly, COM displacements during the lowering phase of the PrefJ were smaller than in the CMJ (Table 1).

Table 1. Mean ± SD whole-body biomechanical parameters during the countermovement (CMJ) and preferred-style (PrefJ) jumps.

|                              | CMJ          | PrefJ         | p-Value | Effect Size |
|------------------------------|--------------|---------------|---------|-------------|
| Peak GRF (N·kg⁻¹)            |              |               |         |             |
| Total                        | 2.53 ± 0.10  | 3.77 ± 0.28   | 0.001   | 2.31        |
| Lead Leg                     | 1.82 ± 0.14  | 2.19 ± 0.23   |         |             |
| Trail Leg                    |              |               |         |             |
| Movement/Contact time (s)    |              |               |         |             |
| Total                        | 0.72 ± 0.05  | 0.40 ± 0.04   | 0.001   | 1.18        |
| Lead Leg                     | 0.39 ± 0.04  | 0.23 ± 0.03   |         |             |
| Trail Leg                    |              |               |         |             |
| Peak pelvis velocity (m·s⁻¹)| 2.88 ± 0.10  | 3.74 ± 0.12   | 0.001   | 3.99        |
| Pelvis displacement (m)      | 0.31 ± 0.02  | 0.09 ± 0.03   | 0.001   | 1.42        |
| Peak jump height (m)         | 0.42 ± 0.03  | 0.71 ± 0.05   | 0.001   | 3.16        |

Note: significant p-values are shown in **bold**. GRF—vertical ground reaction force.
3.2. Joint-Level Parameters

The statistical analysis showed that peak hip and knee flexion angles of the lead leg and peak ankle dorsiflexion angles of the trail leg were smaller during the PrefJ than during the CMJ (Table 2). In contrast, peak hip extension velocities were smaller and peak knee extension velocities were greater during the PrefJ than during the CMJ (Table 2).

Table 2. Mean ± SD joint-level biomechanical parameters during the countermovement (CMJ) and preferred-style (PrefJ) jumps.

|                  | CMJ | PrefJ | p-Value | Effect Size |
|------------------|-----|-------|---------|-------------|
|                  | Lead Leg | Trail Leg | Lead/Trail | Lead/Trail |
| Peak flexion angle (°) | Hip 93.1 ± 8.8 | 67.6 ± 20.8 | 84.7 ± 8.8 | 0.003/0.051 | 0.95/0.67 |
|                  | Knee 94.6 ± 5.9 | 88.3 ± 8.2 | 89.0 ± 11.9 | 0.039/0.218 | 0.62/0.44 |
|                  | Ankle 32.5 ± 2.9 | 37.1 ± 32.4 | 21.8 ± 2.7 | 0.692/0.001 | 0.15/1.31 |
| Peak extension velocity (°·s⁻¹) | Hip 625 ± 105 | 581 ± 147 | 504 ± 60 | 0.608/0.002 | 0.26/0.88 |
|                  | Knee 844 ± 102 | 919 ± 243 | 960 ± 82 | 0.320/0.002 | 0.31/0.82 |
|                  | Ankle 831 ± 51 | 851 ± 101 | 885 ± 89 | 0.464/0.105 | 0.20/0.54 |
| Peak extension NJM (N·m·kg⁻¹) | Hip 2.42 ± 0.24 | 2.96 ± 0.59 | 4.30 ± 0.79 | 0.035/0.001 | 0.78/1.26 |
|                  | Knee 2.09 ± 0.24 | 2.83 ± 0.30 | 3.76 ± 0.46 | 0.001/0.001 | 1.20/1.35 |
|                  | Ankle 1.78 ± 0.11 | 2.13 ± 0.21 | 3.17 ± 0.36 | 0.004/0.001 | 1.08/1.37 |
| Peak positive NJP (W·kg⁻¹) | Hip 8.6 ± 1.2 | 14.2 ± 3.8 | 11.8 ± 3.4 | 0.009/0.022 | 1.06/0.82 |
|                  | Knee 15.2 ± 1.4 | 19.6 ± 2.7 | 22.9 ± 3.3 | 0.001/0.001 | 1.07/1.24 |
|                  | Ankle 11.2 ± 1.0 | 12.8 ± 1.9 | 18.2 ± 2.8 | 0.004/0.001 | 0.71/1.27 |
| Positive NJW (J·kg⁻¹) | Hip 1.36 ± 0.17 | 2.25 ± 0.87 | 1.93 ± 0.48 | 0.024/0.010 | 0.88/0.94 |
|                  | Knee 1.77 ± 0.15 | 2.13 ± 0.47 | 1.78 ± 0.17 | 0.041/0.859 | 0.71/0.05 |
|                  | Ankle 0.98 ± 0.10 | 0.96 ± 0.13 | 1.25 ± 0.14 | 0.640/0.001 | 0.10/1.11 |
| Negative work (J·kg⁻¹) | Hip −1.13 ± 0.35 | −0.60 ± 0.35 | −1.49 ± 0.46 | 0.005/0.184 | 0.92/0.63 |
|                  | Knee −0.94 ± 0.17 | −1.82 ± 0.61 | −2.18 ± 0.17 | 0.003/0.001 | 1.06/1.41 |
|                  | Ankle −0.25 ± 0.06 | −0.75 ± 0.41 | −0.64 ± 0.22 | 0.007/0.002 | 0.98/1.15 |

Note: significant p-values are shown in **bold**. NJM—net joint moment; NJP—net joint power; NJW—net joint work.

The peak extension NJM at all joints of the lead and trail leg were greater during the PrefJ than the CMJ (Table 2). Similarly, the peak positive powers at all joints of the lead leg were greater during the PrefJ than during the CMJ, and the peak positive powers at the knee and ankle joints of the trail leg were greater during the PrefJ than during the CMJ (Table 2).

The positive work at the hip and knee joints of the lead leg were greater during the PrefJ than the CMJ, whereas positive work at the hip and ankle joints were greater during the PrefJ than the CMJ (Table 2). The negative work at the knee and ankle joints of the lead leg were greater during the PrefJ than during the CMJ, whereas the negative work at the hip joint of the lead leg were smaller during the PrefJ than during the CMJ (Table 2). The negative work at all joints of the trail leg were greater during the PrefJ than during the CMJ (Table 2).

3.3. Correlations between CMJ and PrefJ Parameters

There were no significant correlations between the COM parameters of the CMJ and PrefJ (jump height: r = −0.036, p = 0.932; peak GRF: r = 0.489, p = 0.083; ground contact time: r = 0.276, p = 0.508; velocity: r = 0.006, p = 0.989). Similarly, there were very few
significant correlations between joint-level parameters of the CMJ and PrefJ (Table 3). The only significant and strong correlations between CMJ and PrefJ joint-level parameters were found to exist between ankle NJP and positive NJW of the lead leg (Table 3).

**Table 3.** Correlations between joint-level biomechanical parameters of the countermovement jump and the lead and trail legs of the preferred-style jump.

|                  | Lead Leg |            |            | Trail Leg |            |            |
|------------------|----------|------------|------------|-----------|------------|------------|
|                  | r        | p-Value    | r          | p-Value   | r          | p-Value    |
| Peak extension NJM |          |            |            |           |            |            |
| Hip              | 0.232    | 0.581      | −0.155     | 0.715     |            |            |
| Knee             | 0.363    | 0.376      | 0.531      | 0.175     |            |            |
| Ankle            | 0.025    | 0.952      | −0.345     | 0.403     |            |            |
| Peak positive NJP|          |            |            |           |            |            |
| Hip              | −0.415   | 0.306      | 0.366      | 0.373     |            |            |
| Knee             | 0.548    | 0.160      | 0.684      | 0.061     |            |            |
| Ankle            | 0.920    | 0.001      | −0.162     | 0.702     |            |            |
| Positive NJW     |          |            |            |           |            |            |
| Hip              | 0.067    | 0.875      | 0.318      | 0.443     |            |            |
| Knee             | 0.541    | 0.166      | 0.613      | 0.106     |            |            |
| Ankle            | 0.756    | 0.030      | 0.327      | 0.429     |            |            |
| Negative NJW     |          |            |            |           |            |            |
| Hip              | 0.435    | 0.282      | −0.469     | 0.241     |            |            |
| Knee             | 0.362    | 0.378      | −0.174     | 0.680     |            |            |
| Ankle            | 0.640    | 0.087      | −0.127     | 0.764     |            |            |

Note: significant p-values are shown in **bold.** NJM—net joint moment; NJP—net joint power; NJW—net joint work.

4. Discussion

The purpose of this study was to investigate and compare the biomechanics of CMJ and preferred-style (PrefJ) jumps in a group of male collegiate basketball players. We hypothesized that (1) athletes would jump higher and exhibit greater joint-level kinetics using PrefJ than CMJ, and that (2) PrefJ than CMJ would only exhibit partial similarities between jump height and joint-level kinetics. The results of the current study supported our hypotheses in that jump height and joint-level kinetics were greater during the PrefJ than during the CMJ, and that only a limited number of joint-level variables were correlated between the two types of jumps. From a biomechanical perspective, the CMJ does not appear to reflect global maxima of either whole-body or joint-level neuromuscular capacity or represent athlete’s preferred movement patterns during a more sport relevant jumping task. These findings may have practical implications for settings where the CMJ is used to assess and monitor maximal neuromuscular performance of basketball players.

A major finding of the current study was that the PrefJ were characterized by greater jump heights and GRF, shorter ground contact times, smaller COM displacement during the lowering phase, and larger COM velocities than the CMJ. It is worthwhile to briefly consider these findings together with respect to the impulse-momentum theorem. The magnitude of mechanical impulse that is produced and applied to the COM during jumping tasks is directly related to the velocity and jump height of the COM [21]. Given that mechanical impulse is dependent on the magnitude of force and the duration of force application, differences in either of these variables can affect COM velocity and jump height. It is therefore interesting to note that even though the PrefJ exhibited smaller ground contact times and less COM displacement during the lowering phase, the substantially larger GRF during the PrefJ were enough to offset the shorter duration of force application and still produce significantly larger COM velocities and jump heights than during the CMJ [22]. Thus, compared to the CMJ, the biomechanics during the PrefJ are characterized by high-force and short-duration behavior. In addition to the differences in peak COM parameters identified by the pair-wise comparisons, the statistical analysis also showed that peak
GRF, ground contact times, and COM velocities of the PrefJ and CMJ were not strongly correlated. While the participants in the current study may have performed the CMJ with maximal intended effort, the lack of correlations between peak whole-body biomechanical parameters may suggest that the CMJ may only provide limited information about the type of jump a basketball player prefers to use when trying to maximize jumping performance, which is presumably more similar to in-game scenarios. This interpretation is consistent with previous studies that found inadequate evidence about correlations between jump performance of soccer- or basketball-specific jumping tasks and the CMJ [15–17]. These findings may have practical implications for settings where the CMJ is used as a measure of neuromuscular performance or readiness in basketball players [23] and suggest that the ecological validity of the CMJ in the context of assessing and monitoring neuromuscular performance of these athletes should be critically examined and further scrutinized in future studies.

Another primary finding of the current study was that the PrefJ was characterized by greater magnitudes of several joint-level kinetic parameters. More specifically, the PrefJ exhibited much larger peak extension NJM and positive NJP magnitudes than the CMJ, regardless of whether the comparison involved the lead of trail leg during the PrefJ. Since NJM during jumping tasks are largely created by muscles that produce moments of force at a specific joint, peak NJM values are often used to obtain insight about the mechanical demands that are imposed at the respective joint [14]. Although, the ability to generate NJM during any task are subject to constraints imposed by the moment-angle-velocity relationships [24], joint kinematic differences between the CMJ and PrefJ were not as prominent or consistent as joint kinetic differences. Notably, some of the kinematic differences varied across the respective legs during PrefJ, which appeared to be the result of its asymmetric movement pattern [18]. Specifically, hip and knee peak flexion angles of the lead leg during the PrefJ were greater than during the CMJ, whereas peak ankle dorsiflexion of the trail leg was smaller. In contrast, peak hip extension velocity of the trail leg during the PrefJ was smaller than during the CMJ, but peak knee extension velocity was greater. It is therefore difficult to ascribe the differences in joint kinetic to differences in joint kinematics. The discrepancy between CMJ and PrefJ peak joint kinetics may suggest that the NJM magnitudes during the CMJ do not reflect the maximal absolute moment-generating capacity of the extensor muscle groups during dynamic jumping tasks. In addition, the differences in positive and negative NJW would indicate that the athletes used distinctly different movement strategies during the two types of jumps [4,11]. The general lack of correlations between positive and negative NJW during the PrefJ and CMJ supports this conclusion. The jump-dependent difference in movement strategy may help partially explain the smaller NJM and associated lower GRF, COM velocities, and jump heights observed during the CMJ [14], especially if one considers that the task constraints of the CMJ prevent an athlete from using their preferred coordination pattern. The only study to have investigated joint-level differences between a sport-specific jump (i.e., volleyball spike jump) and the CMJ found that the jump heights of both types of jumps were correlated with each other [18]. Although, the authors suggested that this correlation demonstrated that performance of the sport-specific jump is influenced by general jumping ability, they did not investigate correlations between any of the kinematic variables nor did they investigate any kinetic variables. It is therefore not clear if the reported correlation extends beyond general jump performance and to joint-level biomechanics. Like the results and interpretations of the whole-body biomechanical data of the current study, the joint-level biomechanical data suggest that kinematic and kinetic data from the CMJ may only provide limited information with respect to either maximal absolute neuromuscular capacity or movement strategies, which again may have practical implications for using the CMJ as a basketball-specific assessment or monitoring tool in the applied setting.

The results of the current study should be interpreted in light several limitations. First, the CMJ were performed without arm swing whereas the PrefJ were performed with arm swing. Based on known differences between CMJ performed with and without arm
swing [12,13], the CMJ in the current study likely reflect a more restricted type of jumping task. However, jumping tasks exist on a spectrum of constraints and the CMJ and PrefJ used in the current study can be thought of as two types of jumps on the same continuum, albeit at different end points i.e., the CMJ without arm swing would be most constrained whereas the PrefJ with arm swing, run-up, etc. would be least constrained. It is also more common to use the CMJ without arm swing because it better isolates the maximal neuromuscular performance of lower body muscles [1,2]. Future research on different types of restrictions or constraints may therefore provide additional information. A second limitation is that we only screened participants for current injuries. Since previous sprains or fractures could affect CMJ biomechanics it is therefore possible that controlling for such injuries could affect an athlete's PrefJ style and thus influence the results. A third limitation relates to the population of athletes used in the current study. Namely, all participants were basketball players, and the jumping motion adopted by the athletes during the PrefJ in the current study may reflect a specialized strategy that is more common in this population [25,26]. It is therefore possible that differences between CMJ and PrefJ may be less noticeable for athletes who participate in other sports, such as volleyball players who in turn may also have unique preferred jumping styles [18,26]. The purported extent to which the CMJ is a valid tool for assessing and monitoring neuromuscular performance may thus well depend on the population of athletes under consideration.

5. Conclusions

Jump height and joint-level kinetics were greater during the PrefJ than during the CMJ, and only a limited number of joint-level variables were correlated between the two types of jumps. From a biomechanical perspective, the CMJ does not appear to reflect global maxima of either whole-body or joint-level neuromuscular capacity or represent athlete-specific movement patterns that athletes would choose when performing a more sport-relevant maximal vertical jumping task jump with their preferred technique. These findings may have practical implications for settings where the CMJ is traditionally used to assess and monitor maximal neuromuscular capacity or preferred movement patterns of basketball players.

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