

Asymmetry in force production between unilateral and bilateral standing broad jumps in young senior amateur basketball players

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Abstract

The main aim of this study was to assess the between-session reliability of performance and asymmetry variables between unilateral and bilateral standing broad jumps (SBJ). Twenty-four amateur basketball players completed two identical sessions which consisted of four unilateral SBJs (two with each leg) and two bilateral SBJs. Mean and peak values of force, velocity and power, and impulse were obtained separately for each leg using a dual force platform. Inter-limb asymmetries were computed using the standard percentage difference for the unilateral SBJ, and the bilateral asymmetry index-1 for the bilateral SBJ. All performance variables generally presented an acceptable absolute reliability for both SBJs with some exceptions for mean force, mean power, and peak power obtained with both legs. Asymmetry variables always showed unacceptable reliability and slight to fair levels of agreement in their direction except for unilateral SBJ peak velocity and bilateral SBJ peak power that showed moderate agreement for both SBJs. These results highlight that single-leg performance variables can be generally obtained with acceptable reliability regardless of the SBJ variant, but the reliability of the inter-limb asymmetries in the conditions examined in the present study is unacceptable to track individual changes in ground reaction force production.

Keywords: inter-limb asymmetries, variability, force, standing broad jump.

Resumen

El objetivo principal de este estudio fue evaluar la confiabilidad entre sesiones de variables de desempeño y asimetría entre saltos horizontales de pie unilaterales y bilaterales (SBJ). Veinticuatro jugadores de baloncesto amateur completaron dos sesiones idénticas que consistieron en cuatro SBJ unilaterales (dos con cada pierna) y dos SBJ bilaterales. Los valores medios y máximos de fuerza, velocidad y potencia e impulso se obtuvieron por separado para cada pierna utilizando dos plataformas de fuerza. Las asimetrías entre miembros se calcularon utilizando la diferencia porcentual estándar para la SBJ unilateral, y el índice de asimetría bilateral-1 para la SBJ bilateral. Todas las variables de rendimiento generalmente presentaron una fiabilidad absoluta aceptable para ambos SBJs, con algunas excepciones para la fuerza media, la potencia media y la potencia máxima obtenida con ambas piernas. Las variables asimétricas siempre mostraron una fiabilidad inaceptable tanto en magnitud como en dirección. Estos resultados ponen de manifiesto que las variables de rendimiento de una sola pierna se pueden obtener generalmente con fiabilidad aceptable independientemente de la variante SBJ, pero debido al cambio de dirección de las asimetrías entre sesiones, la fiabilidad de la inter-asimetrías de las extremidades en las condiciones examinadas en el presente estudio son inaceptables para seguir los cambios individuales en la producción de fuerzas de reacción.

Palabras clave: asimetrías entre miembros, variabilidad, fuerza, salto horizontal.

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Introduction

Basketball requires a high degree of bimanual dexterity and the use of both legs, either simultaneously or in isolation¹. For this reason, in basketball training, to increase the performance and the level of the players, a symmetrical domain of both arms and legs is affected. Čvorović² shows the existence of significant differences in the use between the dominant and non-dominant hand and leg, symmetry, as the level of competition in which the players participate increases.

The assessment of inter-limb asymmetries has been a frequent source of investigation in recent years in the fields of rehabilitation and strength and conditioning. Previous studies have suggested that lower inter-limb asymmetries may be associated with a lower injury incidence and a safer return to play. For that reason, it has been recommended that clinicians and coaches frequently evaluate inter-limb differences throughout a training cycle in order to ensure that their patients or athletes do not exceed an arbitrary “high risk threshold” (e.g., 10-15%). Since multiple strength and jumping tests have been used to monitor the existence of inter-limb asymmetries, of special interest to practitioners should be the identification of the most appropriate test and metric for an accurate diagnosis of inter-limb differences³.

The standing broad jump (SBJ) likely is the test most frequently used for detecting inter-limb differences in the ability to apply force in a horizontal direction. The main goal of any variant of the SBJ is to jump as far as possible. The high applicability of the SBJ tests comes from the fact that a simple tape measure can be used to determine the main performance indicator.

Due to the lack of similar studies, it seems reasonable to explore the consistency in the direction of asymmetries between consecutive sessions during the unilateral and bilateral SBJ variants. To address the existing gaps in the literature, specifically, the aim of this study was to clarify whether single-leg performance and inter-limb asymmetries can be obtained with a higher between-session reliability during unilateral or bilateral SBJs. Specifically, the aim of this study was to elucidate whether single-leg performance and inter-limb asymmetries can be obtained with a higher reliability during unilateral or bilateral Standing Broad Jumps (SBJs).

The need to increase performance, especially in learning stages, through the symmetrical use of both legs and hands, leads us to ask the following

research questions; Where the different between left and right asymmetries actions come from: is force production between legs or is a learning process and technical execution or are both force production and technical execution. Based on previous findings observed on other jumping-based tasks^{4,5}, it was hypothesized that the reliability of single-leg performance variables would be higher for the unilateral SBJ compared to the bilateral SBJ. However, given that the consistency of the inter-limb asymmetries has been shown to be affected by technical execution^{6,7}, no specific hypothesis was formulated regarding the comparison of the reliability of inter-limb asymmetries between the unilateral and bilateral SBJs

Methods

Subjects

Twenty-four amateur basketball players volunteered to participate in this study. Specifically, the study sample was composed of a senior male (n = 12; age = 18.9 ± 1.8 years [range: 16-22 years]; body mass = 80.2 ± 11.0 kg; body height = 1.88 ± 0.08 m) and female (n = 12; age = 21.1 ± 4.2 years [range: 15-29 years]; body mass = 70.6 ± 7.2 kg; body height = 1.75 ± 0.06 m) team that played in a regional-level Spanish basketball club (data presented as mean ± standard deviation [SD]). All subjects had a minimum basketball experience of five years and they were accustomed to performing the unilateral and bilateral SBJs as part of their habitual strength and conditioning training routines during at least the last two competitive seasons.

Subjects were free from health problems and musculoskeletal injuries that could compromise testing. Prior to testing, subjects were informed about the research purpose and procedures, and they or their legal guardians (for subjects younger than 18 years) gave written consent to participate in the study. The study protocol adhered to the tenets of the Declaration of Helsinki and was approved by the Institutional Review Board.

Experimental Design

A repeated-measures design was used to compare the between-session reliability of single-leg performance and inter-limb asymmetry variables between unilateral and bilateral SBJs. Subjects completed two identical sessions separated by seven days. Each testing session consisted of four unilateral SBJ (two trials with each leg) and two bilateral

SBJs. The average value of the two trials per-

formed with each SBJ variant was used for statistical analyses⁷. 11 testing sessions were performed at the same facility, under the direct supervision of the same experimenter, and were held between 19:00–21:00 hours. Subjects were asked to refrain from any strenuous physical activity for at least 24 hours prior to testing days.

Procedures

The twenty-four amateur basketball players completed two identical sessions which consisted of four unilateral SBJs (two with each leg) and two bilateral SBJs. All SBJ tests were performed on two parallel force platforms (Type 9260AA6; Kistler, Winterthur, Switzerland; 0.5 × 0.6 × 0.1 m) embedded in a wooden housing (1.1 × 1.0 × 0.1 m; see Figure 1 for further details). The horizontal GRF data from each force platform were synchronously acquired with the BioWare[®] software (Kistler, Winterthur, Switzerland) at 1,000 Hz. Mean and peak values of force, velocity and power, and impulse were obtained separately for each leg using a dual force platform⁸. Inter-limb asymmetries were computed using the standard percentage difference for the unilateral SBJ, and the bilateral asymmetry in-

dex-1 for the bilateral SBJ, using the equation proposed by Bishop et., [6] ($[(\text{dominant leg} - \text{nondominant leg}) / (\text{dominant leg} + \text{nondominant leg}) * 100]$).

Results

All performance variables generally presented an acceptable absolute reliability for both SBJs (CV range = 3.65-9.81%) with some exceptions for mean force, mean power, and peak power obtained with both legs (CV range = 10.00-15.46%). Three out of 14 variables ((mean force of the left leg and peak force of both legs) were obtained with higher reliability during the unilateral SBJ (CVratio ≥ 1.18), and 5 out of 14 (mean power and peak velocity of the right leg, as well as mean velocity, peak velocity, and impulse of the left leg) during the bilateral SBJ (CVratio ≥ 1.27). Asymmetry variables always showed unacceptable reliability (IC-Crange = -0.40 to 0.58), and slight to fair levels of agreement in their direction (Kappa range = -0.12 to 0.40) except for unilateral SBJ peak velocity [Kappa = 0.52] and bilateral SBJ peak power [Kappa = 0.51]) that showed moderate agreement for both SBJs (Figure 2).

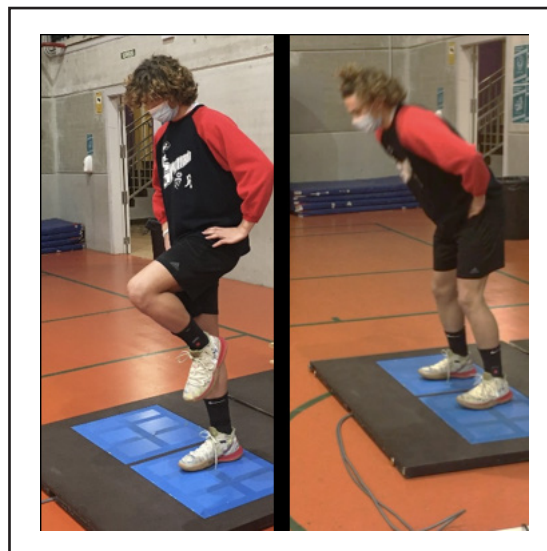


Figure 1. Initial position during the unilateral standing broad jump variant

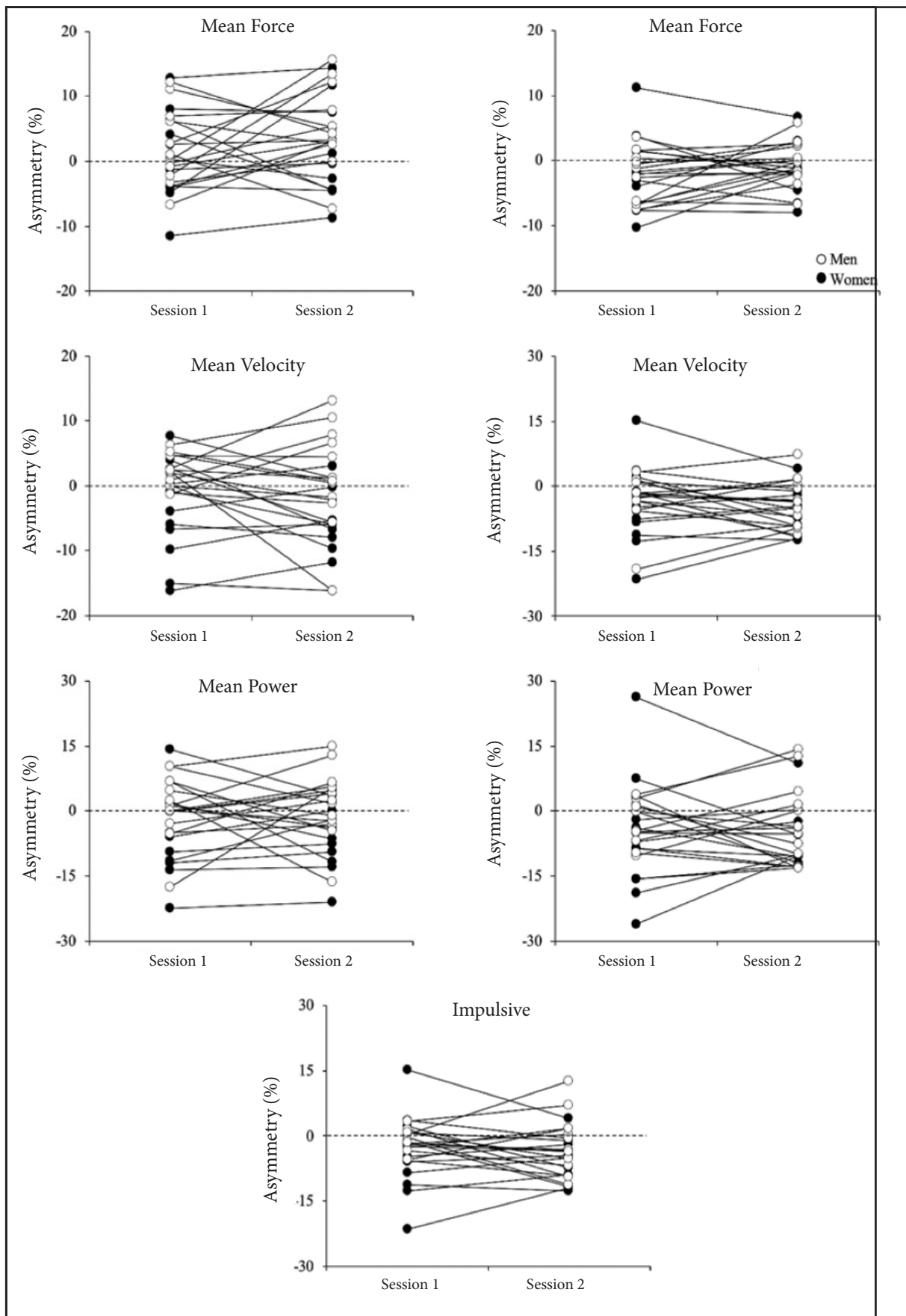


Figure 2. Individual comparisons between both testing sessions for the inter-limb asymmetry scores obtained for men (white circles) and women (black circles) during the bilateral standing broad jump variant

This study was designed to compare the between-session reliability of single-leg performance and inter-limb asymmetry variables between unilateral and bilateral SBJ variants. The main findings revealed that (I) most single-leg performance variables presented an acceptable absolute reliability for both SBJ variants (II) the relative reliability of single-leg performance variables was generally unacceptable for the unilateral SBJ variant, but acceptable for the bilateral SBJ variant; (III) the unilateral SBJ variant reported higher absolute reliability in 3 out of 14 comparisons, while the bilateral SBJ variant was more reliable in 5 out of 14 comparisons; and (IV) the asymmetry variables generally showed unacceptable relative reliability and lack of agreement in their direction for both SBJ variants. These results highlight that most single-leg performance variables can be obtained with acceptable absolute reliability regardless of the SBJ variant. However, the low reliability and lack of agreement observed for the inter-limb asymmetries question their usefulness to classify healthy athletes as asymmetrical during both variants of the SBJ.

Reliability is a basic requirement in the selection of any physical test to guarantee that there is an adequate precision in the outcomes measured to quantify the inter-limb asymmetries^{6,7,9}. To our knowledge, this is the first study to provide in-depth insight into the between-session reliability of various single-leg performance variables obtained with force platforms during the unilateral and bilateral SBJ variants. The present study demonstrated that the different single-leg performance variables have an acceptable absolute reliability for both SBJ variants with some exceptions for mean force, mean power, and peak power. It is plausible that the consistency of mean force values is influenced by the variability in jumping strategy (i.e., force-time characteristics from the initiation of the jump to the take-off)³.

Conclusion

These results highlight that single-leg performance variables can generally be obtained with acceptable reliability regardless of SBJ variant, but the reliability of interlimb asymmetries in the conditions examined in the present study is unacceptable for tracking individual changes in performance due to the variability of the nature of the direction of the asymmetry between sessions. The intersession reliability of the different single-leg performance variables obtained from

the SBJ exercise seems to depend on the unilateral or bilateral variant. Overall, the unilateral SBJ variant might be a more reliable test for quantifying single-leg force production, while the bilateral SBJ variant is a more reliable alternative for measuring comparative single-leg speed, power, or drive performance. because the technical execution of both variants is different. results highlight that single-leg performance variables can be generally obtained with acceptable reliability regardless of the SBJ variant, but the reliability of the inter-limb asymmetries in the conditions examined in the present study is unacceptable to track individual changes in performance due to the nature variability of asymmetry direction. The between-session reliability of the different single-leg performance variables obtained from the SBJ exercise seems to be variant-dependent. In general, the unilateral SBJ variant could be more reliable test to quantify the single- leg force production, while the bilateral SBJ variant is a more reliable alternative to measure the single-leg performance of velocity, power, or impulse.

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