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Is Asymmetry Different Depending on How It Is Calculated?

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Abstract: This study aimed to (1) determine the magnitude and direction of asymmetry in volleyball players, (2) establish asymmetry thresholds, and (3) explore differences depending on the test used and the players' category. Twenty-nine junior and senior male volleyball players were assessed through a muscle asymmetry battery test: active knee extension test (AKE), single-leg countermovement jump (SL-CMJ), single-leg squat jump (SL-SJ), triple hop test for distance (THTD), modified 20-yard shuttle run, Y-balance test, single-leg one-repetition maximum in leg press test (1RM-SL), and lateral symmetry in radial muscle belly displacement through Tensiomyography in the biceps femoris and rectus femoris. A two-way ANOVA alongside an individual analysis of asymmetry thresholds was used to analyze the test and categorize the influence on the magnitude and the direction of asymmetry. The 1RM-SL, SL-SJ, and the lateral symmetry in radial muscle belly displacement showed a clear asymmetry towards the non-dominant side, while the AKE, SL-CMJ, and THTD showed an asymmetry towards the dominant side. The magnitude of the asymmetry was highly variable between tests (1.46–30.26%). The individualized asymmetry thresholds revealed that the percentage of asymmetrical players varied depending on the type of test used. In conclusion, the type of test used determines the magnitude and direction of asymmetry in well-trained volleyball players.

Keywords: asymmetry thresholds; inter-limb differences; imbalance; volleyball

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1. Introduction

Volleyball is a sport characterized by high-intensity short duration and explosive actions with interspersed rest phases [1]. The dynamics of the game involve multiple actions such as jumps, landings, sprints, and multi-directional movements, which emphasize the importance of volleyball players' neuromuscular system. The jump is one of the most outstanding actions in the matches, which differs depending on a player's position. Setters can perform about 136 jumps per game, while middles, opposites and hitters around 97, 88 and 65 jumps respectively [2]. Therefore, it has been suggested that these athletes require well-developed muscle power and speed [3].

Lateral dominance may result in asymmetries, which can be understood as differences in strength, power, stiffness, or range of motion (ROM) between both sides of the player's body [4]. The typical high-intensity actions of team sports (i.e., changes of direction, jumps, hitting, throwing) tend to have a one-sided appearance [5] which can lead to sport-specific adaptions that may entail overloads of body structures [6] and a markedly asymmetric force generations in lower limbs [7]. In volleyball, the jump take-off is performed with one leg ahead depending on the volleyball player's laterality, while the landing is primarily performed one-legged in certain specific varieties of the attack [8–10]. In addition, there are specific zones gestures such as blocks that are normally performed towards the same side [11]. Thus, these repetitive actions in training and competitions can favor the development of asymmetries in volleyball.

Lateral asymmetries have been studied in the scientific literature according to the characteristics of the limbs. Some authors have referred to each leg as the dominant (DL) or non-dominant leg (NDL) [7], the strong or weak leg [12], or just the right and left leg [13]. Yet, all report the inter-limb percentage difference. However, there does not seem to be an absolute consensus on how much a greater or lesser asymmetry affects a player's performance. It has been pointed out that less asymmetry between extremities can improve specific performance actions such as changes of direction [14] or jumping performance [15]. However, other authors have not found significant positive relations between having less asymmetry and better performance [16]. In addition, the asymmetry of volleyball players based on age has not yet been addressed. However, authors such as Loturco et al. [17] have pointed out that the specific adaptations after years of sport specialization in high-level athletes can create inter-limb imbalances.

In the last few years, a bilateral difference was considered as an asymmetry when its magnitude exceeded 10–15% [12,18–20], based on the fact that this difference was associated with a higher risk of injury [21]. However, no consensus has yet been reached on the magnitude of the asymmetry, since this percentage is contemplated as an "arbitrary threshold" which cannot be applied to all assessments nor all populations [22]. Therefore, different procedures have been suggested to determine this percentage of asymmetry in athletes [23]. On the one hand, using the formula mean + (0.2 × SD) [23], was able to classify 42% of athletes with a "small to moderate" inter-limb asymmetry, while on the other hand, applying the more conservative formula mean + (1.0 × DE between subjects), only 16% of athletes were classified as asymmetrical, but with "high or extreme" limb asymmetry. In the first formula, it has been suggested that multiplying 0.2 × SD in elite team sports athletes produces the smallest worthwhile change [24] based on Cohen's effect size. Nevertheless, asymmetry should be individualized [16], as it rarely favors the same limb in all tests [5,25], so it will allow coaches to use these thresholds as reference, criteria, and normative data for specific populations and a variety of metrics and tests. However, to be significant, it needs to be verified that its value of asymmetry (%) must be greater than the coefficient of variation (CV) of the test [26].

The magnitude and direction of asymmetry in well-trained or professional volleyball players has been analyzed very little and has shown inconclusive findings. From a technical point of view, the attack hit has been considered as an asymmetrical action [9], since the forward leg supports most of the load [27]. However, no contralateral differences in the lower limbs were found after assessing asymmetry through a bilateral isokinetic test in German third league players [27] nor with a countermovement jump test (CMJ) in the first Brazilian league [28]. Nevertheless, other authors have observed lower limb asymmetries greater than 10% through a single-leg CMJ (SL-CMJ) test in players with 6 to 10 h training/week [29]. Yet, it is noted that "due to the multi-factorial nature of jumping performance, individual parameters related to performance may not be consistently different" [30]. In this sense, inter-limb differences are suggested to exist in volleyball players; however, the direction of asymmetry appears highly variable depending on the test used to evaluate the athlete [5].

These findings are still inconclusive, mainly due to the different tests that have been performed, the performance level of the players, and the reference percentage to indicate asymmetry. Therefore, it is essential to investigate the magnitude and direction of asymmetry and the reference asymmetry thresholds for well-trained volleyball players to correctly classify players with asymmetry issues. Likewise, it is crucial to establish the differences in asymmetry depending on the test used and the player's performance level (juniors vs. seniors).

Thus, the aims of this study were to determine the magnitude and direction of asymmetry in well-trained volleyball players and to establish asymmetry thresholds through a specific asymmetry battery test for volleyball. Additionally, this study aims to determine the differences in the magnitude and direction of asymmetry, as for the asymmetry thresholds, depending on the tests used and the volleyball players' category (juniors vs. seniors).

2. Materials and Methods

2.1. Study Design

A comparative and cross-sectional study design has been used, following an associative strategy, to determine the direction and magnitude of lateral asymmetry in well-trained volleyball players. The testing battery designed by Iglesias-Caamaño et al. [4,31] to assess muscle asymmetry in volleyball was performed within the players' competitive period.

To determine the magnitude and the direction of asymmetry, the bilateral strength asymmetry (BSA) formula modified by Bishop et al. [5] was used: $([\text{DL} - \text{NDL})/\text{DL} \times 100] \times \text{IF}(\text{DL} < \text{NDL}, 1, -1)$. This formula implements the excel IF function that allows the monitoring of the direction of asymmetry without magnitude variation issues (expressed in %). For this purpose, the attack jump (AJ) leg was chosen as the DL (the left leg for all participants).

2.2. Participants

The sample was composed of 29 male volleyball players from the Spanish Superleague 2 (11 juniors and 18 seniors from different clubs) with a minimum of 8 h training/week and 9 years of volleyball practice experience. The players had an average age of 20.4 ± 4.2 years and an average height of 181 ± 8.0 cm (Stadiometer Seca 213, Seca gmbh and co. kg., Hamburg, Germany). Players' body composition was analyzed through a bioelectrical impedance scale (Tanita BC-601 Segment, Tanita Corporation, Tokyo, Japan), showing an average 75.3 ± 9.1 kg body mass, 12.4 ± 5.2% body fat, and 67.9 ± 9.8 kg muscle mass (see Table 1). All players who volunteered to participate in the study signed an informed consent form before data collection. Coaches and clubs' directors were also informed and approved the testing protocol. The research followed the ethical principles of the Declaration of Helsinki (64 Ed. 2013) and was approved by the Ethics Research Committee of the Faculty of Education and Sports Sciences of the University of Vigo (06-1019).

Table 1. Volleyball players' characteristics based on category.

Category	N	Age (Years)	Height (cm)	Body Mass (kg)	Body Fat (%)	Muscle Mass (kg)
Junior	11	16.5 ± 0.52	179.6 ± 8.6	73.0 ± 10.1	10.6 ± 4.1	61.8 ± 8.3
Senior	18	22.8 ± 3.6	182.1 ± 7.7	76.8 ± 8.5	13.6 ±5.6	71.7 ± 9.0

2.3. Procedures

Before starting the testing protocol, all players carried out their usual warmup. First, they performed 5 min of general mobility, followed by several body weight exercises, and then ended with a free simulation of each test 3 min prior testing. The players made three attempts in each test, retaining the best performance value for analysis [4].

2.3.1. Active Knee Extension (AKE)

The AKE test was used to assess players' hamstring flexibility symmetry. This test has previously been described by Iglesias-Caamaño et al. [4] and is based on angular measurements. A digital goniometer (Baseline Absolute Axis 360°, Fabrication Enterprises, Inc., White Plains, NY, USA) was used to measure players' knee extension with the hip fixed at 90° [32].

2.3.2. Single-Leg Countermovement Jump (SL-CMJ)

The SL-CMJ test was performed on the Chronojump contact platform (Chronojump Bosco-System®, Barcelona, Spain) following the protocol described by Thomas et al. [33]. Players' preformed a single-leg jump with a free flexion angle, but during the entire jump, their hands had to be fixed on the hips. Flight time (s) was retained for data analysis, which was provided by the Chronojump software platform (v. 1.7.0 for Windows) as a direct measure.

2.3.3. Modified 20-Yard Shuttle Run (M-20Y)

The M-20Y test assessed the time spent by the players to cover 20 m with two turns of 180°. The protocol of Sekulic et al. [34] was followed, but subtly modified to perform it unilaterally, varying the turning leg in each attempt as previously described by Iglesias-Camaaño et al. [4] (Figure 1). Microgate polifemo photocells (Microgate Corporation, Bolzano, Italy, Software version 1.10.19.01) were used to measure the time to cover the 20 m distance. Each player performed 6 attempts, 3 turns on the right leg (RL) and 3 turns on the left leg (LL), with 1 min break.

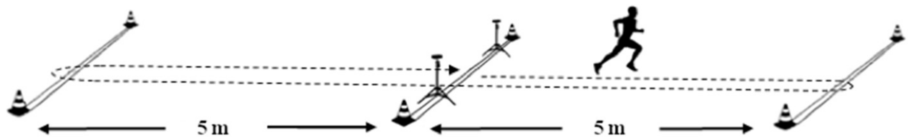

Figure 1. Modified 20-yard shuttle run.

2.3.4. Y-Balance Test (YBT)

The YBT was used to assess the players' lower limbs dynamic balance symmetry using the Y-Balance Test Kit™ (Functionalmovement.com, Danville, VA, USA). Prior to the test, players' lower limb lengths (cm) were measured from the anterior superior iliac crest to the medial malleolus [35] by means of an anthropometric tape measure (Seca 203, Hamburg, Germany). Once measured, the players were assessed following the protocol previously described by Linek et al. [35] and Iglesias-Caamaño et al. [4,31].

2.3.5. Single-Leg One-Repetition Maximum in Leg Press (1RM-SL)

The 1RM-SL test has been used to establish players' maximal concentric strength lateral symmetry. The players positioned themselves one-legged on a leg press ARTIS® (TECHNOGYM®, Cesena, CF, Italy) and pushed the platform until a full knee extension was reached. [31]. The test started with the hips aligned and at an initial 90° knee flexion.

2.3.6. Single-Leg Squat Jump (SL-SJ)

The SL-SJ test was used to establish the lateral symmetry of the players' explosive strength. A single-leg vertical jump was performed, as previously described by Iglesias-Caamaño et al. [31] in a MULTIPOWER® Smith machine (TECHNOGYM®, Cesena, CF, Italy). The test started from a 90° knee flexion [36] at 50% of the player's body weight. The average propulsive velocity of the bar displacement (m/s) was determined through a linear encoder (CHRONOJUMP Boscosystem®, Barcelona, Spain).

2.3.7. Triple Hop Test for Distance (THTD)

The THTD is a horizontal jumping test that consists of performing three consecutive single-leg jumps with each leg aiming to achieve the longest possible length [18]. Players' hands were fixed on the hips and the landing had to be balanced and firm, maintaining the position for 2–3 s. The jump length was measured with a large-distance tape-measure (Bellota 50022-30m, Bellota herramientas, s.l.u, Gipuzkoa, Spain) from the tip of the foot at the starting line to the heel of the third landing.

2.3.8. Radial Muscle Displacement (Dm)

Tensiomyography (TMG) was used to measure players' radial muscle belly displacement of the biceps femoris (BF) and rectus femoris (RF). TMG assessments were performed on both limbs following the protocol described by García-García et al. [37,38].

Radial muscle belly displacement was acquired using a digital displacement transducer (GK 30, Panoptik d.o.o., Ljubljana, Slovenia) set perpendicular to the thickest part of the muscle belly following Perotto's et al. [39] indications. The self-adhesive electrodes (5 × 5 cm, Cefar-Compex Medical AB Co., Ltd., Malmö, Sweden) were placed symmetrically at 5 cm from the sensor. An electrical stimulation was applied with a pulse duration of 1 ms and an initial current amplitude of 30 mA that was progressively increased in 10 mA steps until it reached 110 mA (maximal stimulator output). The electrical stimulus was produced by a TMG-S2 (EMF-FURLAN & Co. d.o.o., Ljubljana, Slovenia) stimulator. The percentage of lateral symmetry (LS) was calculated through algorithm (1), implemented by the TMG-BMC Tensiomyography® software.

$$Ls = 0.1 \cdot \frac{\min(TDr \cdot TDl)}{\max(TDr \cdot TDl)} + 0.6 \cdot \frac{\min(TCr \cdot TCl)}{\max(TCr \cdot TCl)} + 0.1 \cdot \frac{\min(TSr \cdot TSl)}{\max(TSr \cdot TSl)} + 0.2 \cdot \frac{\min(DMr \cdot DMl)}{\max(DMr \cdot DMl)} \quad (1)$$

2.4. Statistical Analyses

Adequacy sample size was calculated using G*Power v3.1.9.4 for Windows (Heinrich-Heine-Universität Düsseldorf, Germany) based on an effect size of 1.10, an alpha error of 0.05, and a power of 0.95. The univariate Kolmogorov–Smirnov test in conjunction with the Lilliefors test demonstrated the sample's normality. The homoscedasticity assumption was verified using Box's M test for equivalence of covariance, followed by a Tukey's HSD post hoc test. Relative reliability was calculated through intraclass correlation coefficient (ICC) analysis using single measurements, two-way mixed effects models, and absolute agreement. The coefficient of variation (CV) was used as a measure of absolute reproducibility. The influence on the magnitude and direction of asymmetry was examined by performing a two-way ANOVA using a test factor (within subjects) and a category factor (between subjects). Finally, an individual analysis of asymmetry was carried out establishing specific asymmetry thresholds following the formula %Asym + (0.2 × SD) [23] or the fixed asymmetry thresholds commonly used in scientific literature (10–15% difference between legs) [12,19]. Additionally, a two-way ANOVA was used to determine if the number of volleyball players classified as "asymmetrical" was modulated by the asymmetry threshold used and/or by the test. The effect sizes in the ANOVA two-way were reported as partial eta squared measurements (η_p^2) and interpreted as small (0.01), moderate (0.06), or large (0.14) [40]. An alpha level of $p < 0.05$ was considered statistically significant. All data were analyzed using SPSS v.24.0 for Windows (SPSS Inc., Chicago, IL, USA).

3. Results

Relative and absolute reliability values (ICC and CV respectively) were 0.92 and 2.2% for AKE, 0.89 and 3.1% for SL-CMJ, 0.77 and 2.5% for M-20Y, 0.93 and 2.6% for YBT, 0.87 and 13% for SL-SJ, 0.63 and 8.6% for THTD, and 0.98 and 3.8% for Dm.

The magnitude of asymmetry obtained by the volleyball players in each test based on their level of performance is shown in Table 2.

The analysis of variance results indicated large significant differences between tests when determining the magnitude of lateral asymmetry (F = 25.194; p = 0.001; η_p^2 = 0.476) but not between categories (F = 0.1951; p = 0.164; η_p^2 = 0.008) nor in test x category interaction (F = 0.961; p = 0.473; η_p^2 = 0.033).

The percentage of asymmetry calculated with the AKE was lower than with the SL-CMJ (p = 0.001), the 1RM-SL (p = 0.001), the SL-SJ (p = 0.001), the Dm of BF (p = 0.001), and the Dm of RF (p = 0.001). This percentage with SL-CMJ was of greater magnitude than the AKE and M-20Y (p = 0.027) and lower than the Dm of BF (p = 0.001) and RF (p = 0.001). The asymmetry detected with M-20Y was significantly lower than when using the SL-CMJ, the 1RM-SL (p = 0.003), the SL-SJ (p = 0.004), the Dm of BF (p = 0.001), and the Dm of RF (p = 0.001). Along this same line, the YBT obtained less asymmetry than the 1RM-SL (p = 0.004), SL-SJ (p = 0.007), Dm of BF (p = 0.001), and Dm of RF (p = 0.001).

The 1RM-SL obtained a greater asymmetry than the YTB (p = 0.004) and the THTD (p = 0.024); however, it was lower than when the Dm of BF (p = 0.001) and the Dm of RF (p = 0.001) were used. The percentage of asymmetry using the SL-SJ was also greater than with the YBT (p = 0.007) and the THTD (p = 0.037) but lower than with the Dm of BF (p = 0.001) and with the Dm of RF (p = 0.001). For the THTD, a lower percentage of lateral symmetry was obtained than the Dm of BF (p = 0.001) and Dm of RF (p = 0.001).

Finally, the Dm of BF and the Dm of RF obtained a magnitude of asymmetry greater than all other tests.

Table 2. Descriptive statistics of the magnitude of lateral asymmetry of the volleyball players.

Test	Category	Mean (%)	SD	IC 95%		Asymmetry Threshold
AKE	Junior	2.859	2.374	1.638	4.079	
	Senior	1.766	1.464	1.292	2.241	
	Total	2.098	1.838	1.606	2.590	2.46
SL-CMJ	Junior	9.636	4.567	1.709	20.981	
	Senior	8.451	7.565	5.626	11.276	
	Total	8.559	7.300	5.970	11.147	8.93
M-20Y	Junior	1.469	1.148	1.382	4.320	
	Senior	1.645	1.219	1.190	2.100	
	Total	1.629	1.197	1.205	2.053	1.87
YBT	Junior	4.904	3.230	3.243	6.565	
	Senior	3.180	3.494	2.031	4.328	
	Total	3.713	3.479	2.772	4.653	4.41
1RM-SL	Junior	9.627	8.775	2.291	16.963	
	Senior	13.319	3.847	8.542	18.097	
	Total	11.047	7.304	6.634	15.461	12.51
SL-SJ	Junior	12.387	10.280	3.793	20.981	
	Senior	9.522	12.515	6.018	25.061	
	Total	11.285	10.768	4.778	17.792	22.25
THTD	Junior	4.056	3.760	1.367	6.746	
	Senior	5.621	8.474	1.464	12.705	
	Total	4.751	6.139	1.698	7.804	5.98
Dm.BF	Junior	29.804	24.110	13.607	46.001	
	Senior	20.997	11.919	9.974	32.021	
	Total	26.379	20.288	16.290	36.468	30.44
Dm.RF	Junior	30.275	15.330	19.976	40.574	
	Senior	22.582	11.710	11.752	33.412	
	Total	27.283	14.196	20.224	34.343	30.12

AKE: active knee extension test, SL-CMJ: single-leg countermovement test, M-20Y: modified 20-yard shuttle run test, YBT: Y-balance test, 1RM-SL: single-leg one-repetition maximum test in leg press, SL-SJ: single-leg squat jump test, THTD: triple hop test for distance, Dm.BF: radial muscle belly displacement of the biceps femoris, Dm.RF: radial muscle belly displacement of the rectus femoris, SD: standard deviation.

The ANOVA results were similar to those shown previously in the analysis of the magnitude (without the direction), finding moderately significant differences between tests when determining the magnitude and direction of the lateral asymmetry (F = 1.961; p = 0.044; η_p^2 = 0.066), but not between categories (F = 0.297; p= 0.586; η_p^2 = 0.001). However, when we analyzed the magnitude and the direction jointly, the interaction test × category (F = 2.499; p = 0.009; η_p^2 = 0.083) indicated a moderately significant difference.

As can be seen in Figure 2, in the AKE, the SL-CMJ, and the THTD, the asymmetry was towards the NDL in both categories (less performance in the right leg). The 1RM-SL, the SL-SJ, and the Dm of BF showed an asymmetry towards the DL (less performance in the left leg). The M-20Y, the YBT, and the Dm of RF showed different orientations depending on the evaluated category (junior vs. senior).

For the category × test interaction, a greater lateral asymmetry was found in the seniors' 1RM-SL (−13.32% vs. −2.75%) and SL-SJ (−8.05% vs. −1.74%) and a greater asymmetry in junior players was found in the Dm of BF (−15.86% vs. −3.99%) and the Dm of RF (−18.24% vs. 6.89%).

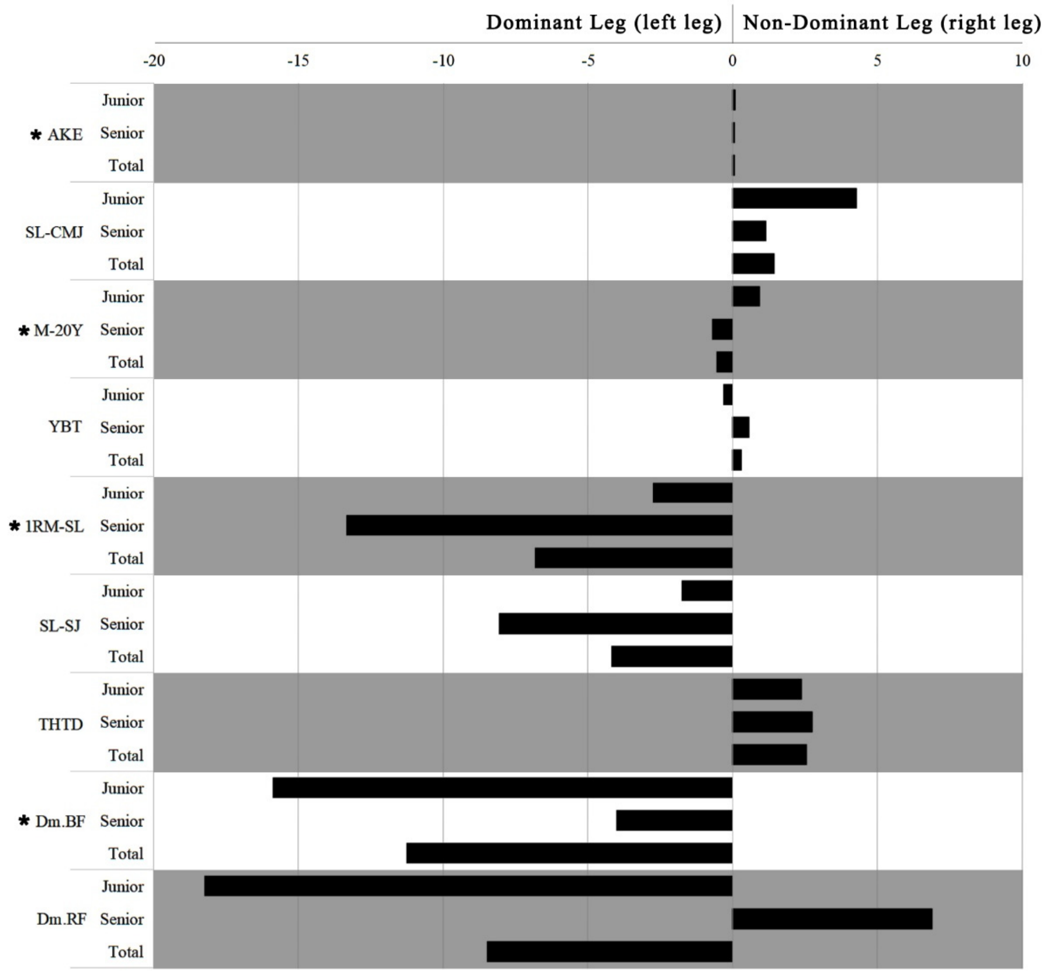

Figure 2. Magnitude of lateral asymmetry of the volleyball players obtained in each test. A positive percentage indicates a direction of asymmetry towards the DL (left leg) and a negative percentage indicates an asymmetry towards the NDL (right leg). *: Significant (p < 0.05); AKE: active knee extension test; SL-CMJ: single-leg countermovement test; M-20Y: modified 20-yard shuttle run test; YBT: Y-balance test; 1RM-SL: single-leg one-repetition maximum test in leg press; SL-SJ: single-leg squat jump test; THTD: triple hop test for distance; Dm.BF: radial muscle belly displacement of the biceps femoris; Dm.RF: radial muscle belly displacement of the rectus femoris; DL: dominant leg, NDL: non-dominant leg.

The individualized analysis for each player based on each test asymmetry threshold, using (a) the specific asymmetry threshold formula or (b) the 10% fixed asymmetry thresholds, shows that there are not any significant differences in the determination of volleyball players' lateral asymmetry (F = 0.015; p = 0.903; η_p^2 = 0.001). However, there are significant differences in the determination of volleyball players' lateral asymmetry in the threshold × test interaction (F = 4.404; p = 0.004; η_p^2 = 0.662) with a large effect size. In addition, there are differences in test (F = 3.266; p = 0.018; η_p^2 = 0.592) that also show a large effect size.

Specifically, when using the specific asymmetry threshold formula, the percentage of classified players as asymmetrical is between 15.38% for the SL-SJ test and 42.86% for the YBT test. However, if the fixed threshold of 10% difference between limbs is used, the percentage of asymmetrical players significantly varies between 0% (AKE and M-20Y tests) and 88.89% (Dm of RF test).

4. Discussion

Our main findings indicate that the type of test used determines the magnitude and direction of asymmetry, and the asymmetry thresholds of well-trained volleyball players. Furthermore, when analyzing a player's category together with the test used, there is an interaction that also influences the magnitude and direction of asymmetry. The 1RM-SL, SL-SJ, and Dm of BF showed a clear asymmetry towards the DL, that is, the left leg had an less performance. In contrast, the AKE, SL-CMJ, and THTD showed asymmetry towards the NDL, being the right leg, which had less performance. Very variable magnitudes of asymmetry have been found between the tests that composed our battery (1.46–30.27%). The individualized analysis using specific asymmetry thresholds again reveals that the type of test performed modulates the percentage of players considered asymmetrical, ranging between 15.38% in the SL-SJ and 42.82% in the YBT. When using the 10% fixed threshold, the values hover between 0% for the AKE and M-20Y tests and 88.89% for the Dm of RF.

The ICC and CV values obtained were good to excellent for all tests, except for THTD's relative reliability, which was moderate. This corroborates the good reliability of this battery test that Iglesias-Caamaño et al. [4,31] had previously reported.

Overall, these findings are in line with those recently reported by Kozinc and Šarabon [41] with young volleyball players. These authors also found a highly variable magnitude of asymmetry (2.0–31.2%) among their wide battery tests. In addition, their magnitudes of asymmetry were similar to ours in the tests that they had in common with our testing battery (COD: 1.62 ± 1.19% vs. 2.02 ± 1.83%; SL-CMJ: 8.56 ± 7.3% vs. 10.24 ± 9.39%; THTD: 4.7 5 ± 6.14% vs. 4.3 ± 2.8%). Therefore, with due prudence these data could serve as a reference of asymmetry for volleyball players.

Regarding the magnitude of asymmetry found in soccer players, it seems that the asymmetry shown in well-trained volleyball players does not differ significantly through an isokinetic test in concentric and eccentric contractions [42] nor those evaluated by a unilateral 1RM (9.9 ± 7.2% vs. 11.04 ± 7.3%) [43]. Similarly, our volleyball players did not differ from the asymmetry values revealed by recreational rugby and soccer players assessed through a SL-CMJ (7.2 ± 6.1% vs. 8.56 ± 7.3%) [25], nor those reported by Meylan et al. [19] showing an asymmetry index of 6.0% in 30 team athletes. Along these lines, our findings indicate similar values of asymmetry to netball players in COD tests [44], although in a different test (505 agility test: 2.3 ± 2.3% vs. M-20Y 1.69 ± 1.2%). In addition, our findings in the YBT are in line with those of Ryu et al. [45] in professional baseball players, finding no significant differences in the analysis of direction between DL and NDL. However, volleyball players appear to have less asymmetry in active knee mobility (AKE) than Gaelic football players [7], where they observed 5.5 ± 4.8% asymmetry in their 570 players compared to the 2.1 ± 1.84% asymmetry observed in our 29 volleyball players. These differences between volleyball and Gaelic football players may be due to their differences in the mechanical performance model, since volleyball players perform actions in much smaller spaces with less pronounced changes of direction and in lower defensive positions than Gaelic football players. Regarding the Dm of the BF and RF, it seems that our volleyball players show higher values of inter-limb asymmetry (26.38 ± 20.29% and 27.28 ± 14.20%, respectively) than those reported in elite futsal players [46]. In contrast, Rodríguez-Ruiz et al. [47] found no significant inter-limb differences in these parameters in professional volleyball players, nor did García-García et al. [48] in professional soccer players. However, the latter authors pointed out that these asymmetries can vary throughout the soccer player's season. Notwithstanding, asymmetry in these studies was not calculated using an index, so these findings should be compared with caution. Therefore, these differences between authors could be to a certain extent due to the methodological differences in data collection to reach the maximum Dm, the different time of the season, and the differences in the mechanical performance model (i.e., ball kick in soccer vs. futsal).

The determination of the magnitude together with the direction of asymmetry requires a more in-depth analysis to be able to correctly interpret the findings. First, it is necessary to establish an appropriate criterion to determine which is the DL of the athlete, as it will mark the direction of magnitude towards their DL or NDL in the evaluated task [5]. This is because it seems that the dominance in limbs is rarely the same between different tasks, as it has been suggested in recreational athletes [5] or between tests such as THTD and CODs [16]. In these lines, our findings indicate that the 1RM-SL, SL-SJ, and Dm of the BF show a clear asymmetry towards the DL, that is, the performance of the DL should be improved to reduce asymmetry. This lateral asymmetry is possibly due to the need to produce great levels of maximum strength in the 1RM-SL and SL-SJ and the high muscle tone in the Dm of BF of the NDL. Nevertheless, the AKE, SL-CMJ, and THTD clearly show an asymmetry towards the NDL, that is, the performance of the NDL should be improved to reduce asymmetry. This lateral asymmetry is probably caused by the need to exert explosive and reactive force during a greater ROM with the DL in the volleyball mechanical model. In view of these circumstances, it seems advisable to determine the dominant limb of each player for each test performed.

In relation to the magnitude and direction of asymmetry based on category, small differences have been observed in terms of direction between categories. Tasks such as the M-20Y showed asymmetry towards the NDL while the YBT and Dm of RF towards the DL in seniors. Hence, it is possible that specific volleyball adaptions may create asymmetries in lower limbs over the years. Therefore, the years of practice seem to influence an increase in asymmetry in jumping and strength tasks (i.e., 1RM and SL-SJ); however, at younger ages these differences seem to appear in muscle tone.

The limitations that arise in the interpretation of the magnitude and the magnitude and direction of asymmetry analyzed together suggest that an individual approach is necessary for each player to determine whether there is a lateral asymmetry. Traditionally, in the scientific literature it has been suggested that an inter-limb difference of >10–15% implies an asymmetry [49]. However, it has recently been pointed out that the threshold to consider an athlete asymmetrical should be established based on the sample assessed and the type of test carried out [5]. In fact, it has been suggested that the commonly accepted >10% threshold for classifying individuals as asymmetrical should be reconsidered and reinvestigated [41]. This individualization would allow those interested to really determine in which motor skills the player is asymmetrical. Our findings indicate that different results are obtained depending on the asymmetry criterion, whether using the fixed asymmetry threshold of >10–15% inter-limb difference or the specific asymmetry threshold for each category of athletes and each test carried out. For example, the AKE test did not show asymmetries >10% for any player, but if we use the specific asymmetry threshold considering the category and the test, 31.03% of the players would be classified as asymmetrical. Similarly, Dos'Santos et al. [44] detected a 30% fraction of asymmetrical athletes with a specific asymmetry threshold for the 505 agility test, while using the fixed asymmetry threshold >10% only a 5% of athletes these were identified. In fact, Kozinc and Šarabon [41] found no asymmetries in volleyball players when applying the fixed asymmetry threshold (>10%) in two agility tests with 180° and 90° turns, as in our study with the M-20Y. However, the number of asymmetrical players found in our study was 41.67% if we used that specific asymmetry threshold.

Several limitations must be considered when interpreting our findings. On the one hand, the low number of volleyball players in our sample does not allow for reference data to be collected. Therefore, a representative sample of volleyball players is needed to obtain reference thresholds. On the other hand, the lack of female players in our sample limits our findings only to male volleyball players, so it is undoubtedly necessary to address gender differences in the future.

5. Conclusions

In conclusion, the type of test used determines the magnitude and direction of asymmetry and the asymmetry thresholds of well-trained volleyball players. It seems necessary to carry out a variety of specific volleyball tests that assess strength, power, agility, ROM, balance, and especially, sport-specific technical gestures (such as the attack hit in volleyball) to globally understand a player's asymmetry. In addition, it also seems necessary to establish an individual asymmetry analysis for each player based on a specific asymmetry threshold for the athlete's category and the test used. In this sense, reference values are required for specific asymmetry thresholds to be able to classify the volleyball players. This would help establish the necessary training strategies (strength, flexibility, etc.) to improve the imbalance. Furthermore, this could be transferred to other sports through an appropriate specific testing battery that includes tests that assess certain specific aspects related to the performance factors of the sport in question.

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