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Effects of Vertical and Horizontal Jumping Asymmetries on Linear and Change-of-Direction Speed Performance of Female Soccer Players

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Abstract: In recent years, along with the remarkable development of women's soccer, significant attention has been given to the study of asymmetry in lower limbs. However, there is uncertainty about whether and to what extent jumping asymmetries affect the performance of female soccer players. The aims of this study were to examine (a) possible asymmetries in jumping ability and (b) the correlations between asymmetries and performance of female soccer players in 10 m and 30 m speed tests, as well as in change-of-direction speed tests. The study involved 12 adolescent (age: 15.8 ± 0.8 years, body mass: 59.4 ± 7 kg and height: 160.5 ± 5.1 cm) and 10 adult female soccer players (age: 22.3 ± 4.4 years, body mass: 62.2 ± 7.5 kg and height: 165.7 ± 6.1 cm). Pearson's correlations showed no statistically significant relationships between vertical and horizontal asymmetries and time in 10 m, 30 m and 505 change-of-direction speed tests for adolescent players. In adult players, a significantly high correlation was found between asymmetries in single-leg hop tests (for distance) and time in 505 change-of-direction speed tests (r = 0.68, $p < 0.05$). Adult players showed higher asymmetry values in vertical and horizontal jump tests, but these asymmetries were not significant ($p > 0.05$). Practitioners are recommended to implement strength and power training programs, as well as injury prevention protocols, aiming to reduce asymmetries, in order to minimize the risk of injuries, and potentially improve performance of female soccer players in certain fitness tests.

Keywords: asymmetry; lower limbs; jumping ability; linear speed; change of direction; speed; females; soccer

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1. Introduction

Women's soccer has seen a remarkable growth in popularity and participation over the last decade [1]. This has led to increased demands on physical abilities during training and competition, as well as to higher levels of skills [2]. Given these changes in women's soccer, it seems reasonable that there is a need for a better understanding of the physical demands faced by female soccer players.

At the top level, different assessment tools are proposed to help practitioners reduce the risk of injury and improve the players' performance [3–5]. In recent years, great attention has been paid to the study of asymmetry between the two lower limbs, with several studies reporting the existence of lower limb differences when performing various physical fitness tests [6–8]. The concept of lower limb asymmetries refers to the function of one leg relative to the other, and it is argued that their existence is likely to be due to participation in the same sport for several years [9,10]. Several methods have been used to measure asymmetries between the two legs, such as the isokinetic dynamometer [11,12], unilateral isometric squats or isometric mid-thigh pulls [13,14] and various types of jumps [7,15–17]. It is also noted that greater levels of asymmetry could harm athletes' physical fitness, increase the risk of non-contact injuries and limit skill efficiency [17–19].

Jump tests often are part of the assessment of athletes' physical abilities, being a feasible and time-efficient method, which, in most cases, captures the motor skills associated with the sport [3,20,21], while also identifying athletes at increased risk of injury [22–24]. Furthermore, it is noted that tests with unilateral jumps are probably more appropriate for measuring asymmetries, as there is no contribution of the other leg during their implementation and thus a more realistic picture of asymmetry is obtained [3,25]. Additionally, because there is no clear correlation between the diverse demands of soccer (linear speed, change-of-direction speed, acceleration) and jump tests [26,27], it would be more effective to use more than one test to assess asymmetries.

To our knowledge, only two studies have examined lower limb jumping asymmetries and their association with performance on fitness tests in adult female soccer players. In particular, according to Bishop et al. [28], an asymmetry level of 9.2% was found in single-leg drop jump height, which showed a significant correlation with linear speed (r = 0.52–0.58) and change-of-direction speed (r = 0.52–0.66). However, no correlation was found between the single-leg countermovement jump and linear speed or change-of-direction speed. Moreover, according to Loturco et al. [29], asymmetry levels of 9.8% and 10.6% in jump height, from single-leg squat jump and single-leg countermovement jump, respectively, were not significantly associated with speed and power performance in adult female professional soccer players. In addition, contradictory results were found in another two studies of adolescent and pre-adolescent female soccer players, according to the effect of jumping asymmetries on performance in fitness tests. Specifically, Bishop, Read, McCubbine and Turner [15] found a significant correlation between asymmetries in the single-leg countermovement jump and girls' speed performance (r = 0.49–0.59) at 5 m, 10 m and 20 m, whereas asymmetries observed in the horizontal jump tests showed no significant correlation with speed times. In contrast, Pardos-Mainer, Bishop, Gonzalo-Skok, Nobari, Pérez-Gómez and Lozano [30] used a 180° change-of-direction speed test, a horizontal single-leg jump and a single-leg countermovement jump and found asymmetry levels of 2.9%, 4.8% and 11.6%, respectively, but these asymmetries showed no significant correlation with linear and change-of-direction speed performance.

Thus, it can be argued that there is an uncertainty in the results regarding whether and to what extent jumping asymmetries affected the performance of female soccer players. Indeed, the limited number of studies in this population makes it more difficult to provide clear conclusions. Furthermore, the fact that team sports athletes who exhibit greater asymmetry values in jump tests and reduced jumping ability seem to be at higher risk of injury [31], as well as the indication that female soccer players have a higher frequency of severe injuries than males [32], underline the need to study jumping asymmetries. Therefore, the aims of the present study were to examine (a) possible lower limb jumping asymmetries in adolescent and adult female soccer players and (b) the correlation of asymmetries with performance of female soccer players in fitness tests, such as 10 m and 30 m sprint and change-of-direction speed. It was hypothesized that asymmetries in vertical jump tests would be greater than those in horizontal jump tests and that there would be a positive correlation between jumping asymmetries and speed times.

2. Material and Methods

2.1. Participants

Twenty-two female soccer players participated in this study. Twelve of the participants were adolescent players (age: 15.8 ± 0.8 years, body mass: 59.4 ± 7 kg, height 160.5 ± 5.1 cm and body fat: 27.8% ± 4.5%), playing in the same club of Category 2 Women's Soccer in Greece, and ten participants were adult players (age: 22.3 ± 4.4 years, body mass: 62.2 ± 7.5 kg, height 165.7 ± 6.1 cm and body fat: 28.2% ± 4%) of the same club, which took part in Category 1 Women's Soccer in Greece. All female soccer players had at least three years of competition experience and participated in the current season in non-resistance strengthening programs with a frequency of once a week. In total, they took part in three to four training sessions and one match per week. The subjects had no injuries in a minimum period of two months prior to their participation in the measurements. Participants were informed of the potential risks and benefits of the study and they or their guardian (if the participant was a minor) signed a written informed consent before taking part in the study. This study was approved by the Institutional Review Board of the Exercise Physiology and Sport Rehabilitation Laboratory, Thessaloniki, Greece (No. 04/2022) and is in accordance with the Declaration of Helsinki.

2.2. Procedures

The tests were carried out on synthetic turf during the in-season period. The participants familiarized themselves with the tests they are going to administer before the evaluation. Also, the dominant leg was identified, according to the leg with which they preferred to kick the ball [33]. Height, body mass and body fat were measured, and participants' athletic history data were collected. Field tests were performed on the same day, at least 48 h after intense exercise and with the following order: vertical and horizontal jumps (randomized), 10 m and 30 m sprints and change-of-direction speed (COD) test. The break between jumps was 1 min, while between sprints and COD tests it was 3 min. Between the tests, the break was 5 min. Before field tests, participants followed a ten-minute warm-up protocol relevant to the tests with progressively increasing intensity (running drills, landings, accelerations, decelerations, changes of direction and dynamic stretches of the lower limbs). The characteristics of the warm-up are presented in Table 1. Finally, female soccer players were informed to avoid alcohol and caffeine consumption in the last 24 h before the measurements [29,34], and to have their last meal at least three hours before they visit the field.

Table 1. Characteristics of the warm-up.

Drill	Intensity	Duration
Running drills	Minor–medium	3 min
Landings	Minor–medium	1 min
Acceleration–deceleration	Medium	2 min
Change-of-direction speed	Medium–high	2 min
Dynamic stretches	Medium–high	2 min

2.3. Anthropometric Characteristics

To measure body mass and height, participants were barefoot and in sportswear. An electronic digital scale with integrated stadiometer (Seca 220e, Hamburg, Germany) was used, with an accuracy of 0.1 kg and 0.5 cm, respectively. Body fat percentage was estimated based on the sum of four (biceps, triceps, supra-iliac and subscapular) skinfold thicknesses measured with a specific caliper (Lafayette, Ins. Co., Lafayette, IN, USA) on the right side of the body, as described by Slaughter et al. [35]. Body density was estimated according to the equation of Durnin and Rahaman [36], while body fat percentage was estimated according to the equation of Siri [37].

2.4. Single-Leg Drop Jump (SLDJ)

The single-leg drop jump was conducted from an 18 cm box [7,38], using the CHRONOJUMP Boscosystem (Chonojump, Barcelona, Spain). Participants were asked to step off the box, with their hands on their hips, and land on the ground with the testing leg where a tape was placed. Then, they were asked to minimize the contact time upon landing and perform a jump as high as possible without bending the testing leg in the swing phase [7,38]. Before recording the jumps, participants performed a trial attempt with each leg. Two jumps were performed on each leg, with a 30 s rest between each jump. The best jump was selected for analysis.

2.5. Single-Leg Countermovement Jump (SLCMJ)

For this test, the CHRONOJUMP Boscosystem (Chonojump, Barcelona, Spain) was also used. Participants were instructed to perform a countermovement to a self-selected depth followed by a quick upward vertical movement. They were asked to jump as high as possible with the performing leg extended, during the flight phase, and the hands on the hips. The leg not participating in the jump was slightly flexed at the hip and knee so that it was almost parallel to the ankle of the other leg [28]. Prior to testing, participants performed a trial attempt on each leg. Two jumps were performed on each leg, with a 30 s rest between jumps. The best jump was selected for analysis.

2.6. Single-Leg Hop (SLH for Distance)

Each subject started behind the starting line, standing on their testing leg and with their hands on hips. They were instructed to jump, as far as possible (horizontal distance), and land on the same leg. Participants were also asked to stick the landing position for two to three seconds, otherwise the attempt was invalid and had to be repeated [39]. The distance from the starting line to the subject's heel was defined as the hopping distance and was measured using a measuring tape [39]. Prior to tests, subjects performed a trial attempt on each leg. Two jumps were conducted for each leg, with a 30 s rest between them, and the best jump was used for analysis.

2.7. Sprints (10 m and 30 m)

Electronic timing gates with photocells (Microgate, Bolzano, Italy) were placed at 0 m, 10 m and 30 m, allowing different phases of sprint to be measured. Participants started the test from a standing position, with their front leg approximately 0.3 m before the starting line, to avoid crossing the timing gate before the start of the test. The photocells were placed at a height of 0.6 m from the ground level (approximately at hip level) to record trunk movement and to avoid false signals from leg movement [40]. Before the sprint tests, participants performed a trial effort. When the signal was given, participants ran, as fast as possible, passing through the timing gates. Two attempts were performed on a synthetic turf, with a 90 s rest between them, and the fastest sprint was selected for analysis.

2.8. The 505 Change-of-Direction Speed Test

After measuring a 15 m distance, electronic timing gates with photocells (Microgate, Bolzano, Italy) were placed at 10 m and 15 m. The 15 m distance coincided with the line in the penalty area, so that participants had a visible target as they approached the change-of-direction point. The photocells were placed at a height of 0.6 m above the ground level (approximately at hip level) to record trunk movement and to avoid false signals from leg movement [40]. Before the test, participants performed a trial attempt on each leg. Subjects conducted a 15 m sprint, on a synthetic turf, followed by a 180° change in direction for both legs, with two attempts on each leg. Timing started when subjects passed the gate at 10 m and after the 180° change in direction, before performing a sprint back to the first gate, covering a 10 m distance. A 90 s rest between each attempt was given and the fastest attempt was used for analysis.

2.9. Statistical Analysis

Data are presented as mean ± standard deviation. The normality of data was checked using the one-sample Kolmogorov–Smirnov test ($p < 0.05$). Therefore, a non-parametric test was not necessary. Asymmetry values between the two legs were calculated, as the percentage difference (%), using the following equation: (highest performing leg——lowest performing leg)/highest performing leg × 100 [23]. Pearson's correlation coefficient was used to test the correlation between the asymmetry variables and the fitness tests, and to check the correlation between the asymmetry variables. A linear regression model (R^2) was also used for the prediction of performance by the asymmetry variables. Finally, the independent sample *t*-test was used to compare the mean values on the measured variables between adolescent and adult female soccer players. Statistical significance was set at $p < 0.05$.

3. Results

Correlations between asymmetry variables and time, in linear and change-of-direction speed tests for adolescent and adult female soccer players, are presented in Tables 2 and 3, respectively. No statistically significant correlations between jumping asymmetries and linear and change-of-direction speed were found for adolescent female soccer players. A significant positive correlation (r = 0.68, $p < 0.05$) between asymmetry in single-leg hop for distance and speed time in change-of-direction on the right leg (preferred leg) was found for adult female soccer players. No significant correlations were shown between the other asymmetry variables and time in linear and change-of-direction speed.

Table 2. Correlations between asymmetry variables and linear and change-of-direction speed times for adolescent female soccer players.

Asymmetry Variables (%)	10 m (s)	30 m (s)	505—Right Leg (s)	505—Left Leg (s)
SLDJ	0.23	0.14	0.11	0.39
SLCMJ	0.36	0.21	−0.02	0.32
SLH (for distance)	0.39	0.27	0.27	0.11

Note: SLDJ = single-leg drop jump, SLCMJ = single-leg countermovement jump, SLH = single-leg hop.

Table 3. Correlations between asymmetry variables and linear and change-of-direction speed times for adult female soccer players.

Asymmetry Variables (%)	10 m (s)	30 m (s)	505—Right Leg (s)	505—Left Leg (s)
SLDJ	−0.55	0.19	−0.04	−0.19
SLCMJ	0.58	0.46	0.36	0.28
SLH (for distance)	0.24	0.04	0.68 *	0.08

Note: SLDJ = single-leg drop jump, SLCMJ = single-leg countermovement jump, SLH = single-leg hop, * = $p < 0.05$.

Correlations between asymmetry variables for adolescent and adult female soccer players are presented in Tables 4 and 5, respectively.

Table 4. Correlations between asymmetry variables for adolescent female soccer players.

Asymmetry Variables (%)	SLDJ Asymmetry (%)	SLCMJ Asymmetry (%)	SLH Asymmetry (%)
SLDJ	1.00	0.74 **	−0.08
SLCMJ	0.74 **	1.00	0.03
SLH (for distance)	−0.08	0.03	1.00

Note: SLDJ = single-leg drop jump, SLCMJ = single-leg countermovement jump, SLH = single-leg hop, ** = $p < 0.01$.

Table 5. Correlations between asymmetry variables for adult female soccer players.

Asymmetry Variables (%)	SLDJ Asymmetry (%)	SLCMJ Asymmetry (%)	SLH Asymmetry (%)
SLDJ	1.00	−0.57	0.21
SLCMJ	−0.57	1.00	−0.20
SLH (for distance)	0.21	−0.20	1.00

Note: SLDJ = single-leg drop jump, SLCMJ = single-leg countermovement jump, SLH = single-leg hop.

The linear regression models used were unable to adequately predict linear and change-of-direction speed performance for adolescent female soccer players. In contrast, when vertical and horizontal jumping asymmetries were considered as independent variables, they were able to explain 73% of the variance in change-of-direction speed time on the right leg in adult female soccer players. The mean differences between two groups, in asymmetry values and in linear and change-of-direction speed times, are presented in Figures 1 and 2, and in more detail in Table 6.

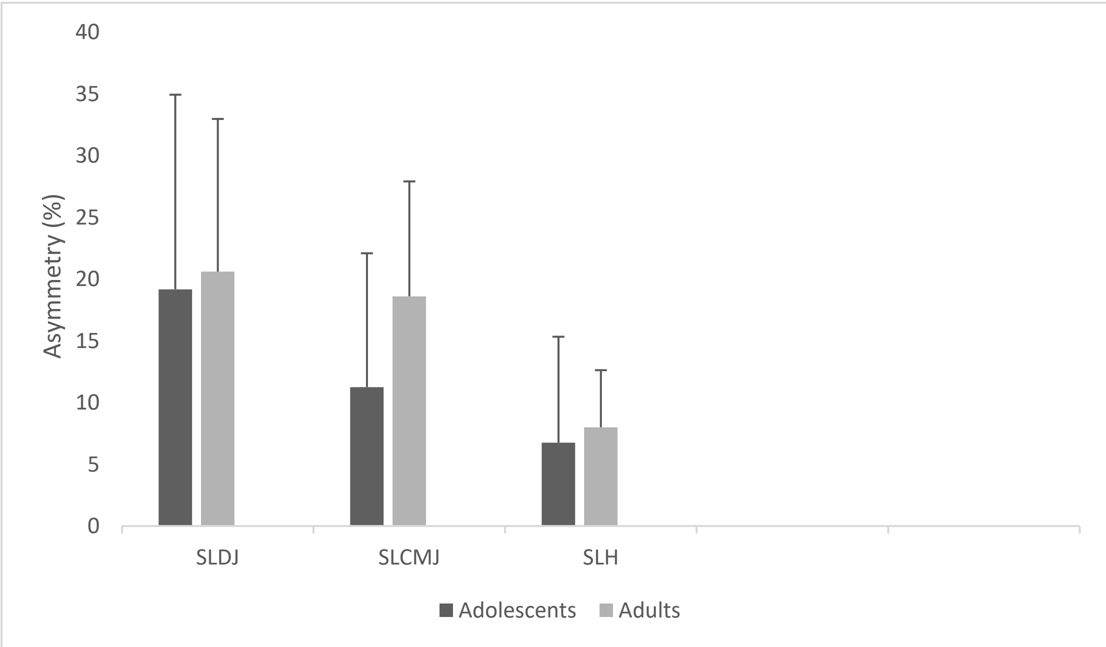

Figure 1. Vertical and horizontal jumping asymmetries (%).

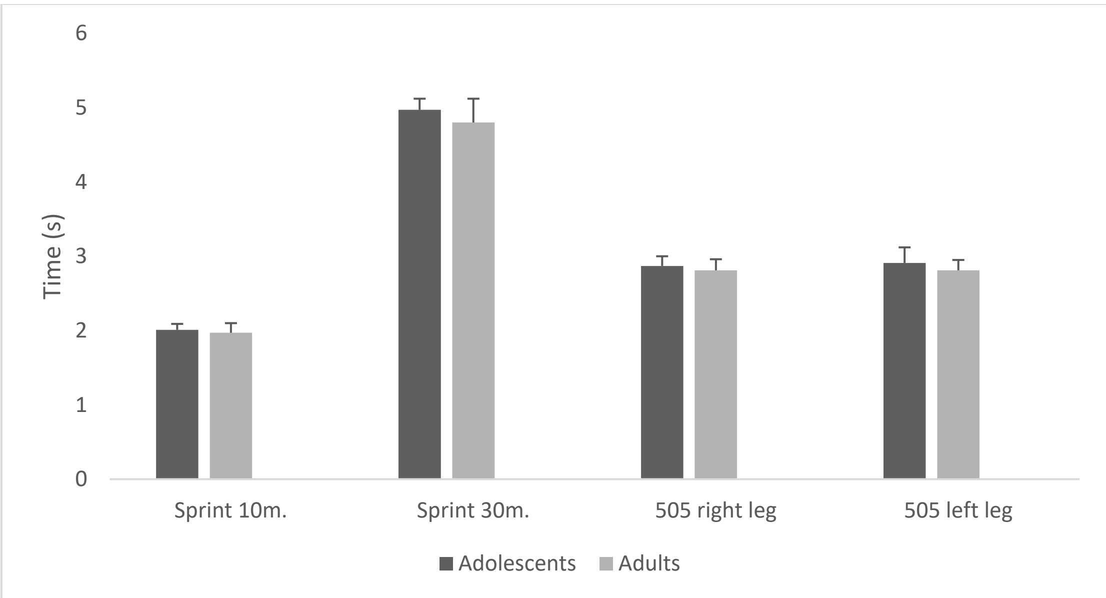

Figure 2. Linear and change-of-direction speed time (s).

Table 6. Mean values for all variables measured in adolescent and adult female soccer players.

Variables	Group	Mean Values	Standard Deviation	t	*p*	Confidence Intervals 95%	Cohen's d
SLDJ asymmetry (%)	Adolescents	19.17	15.76				
	Adults	20.60	12.37	−0.23	0.82	−14.23–11.37	−0.10
SLCMJ asymmetry (%)	Adolescents	11.25	10.84				
	Adults	18.60	9.31	−1.69	0.11	−16.44–1.74	−0.72
SLH asymmetry (%)	Adolescents	6.75	8.58				
	Adults	8.00	4.62	−0.41	0.68	−7.57–5.07	−0.18
Sprint 10 m (s)	Adolescents	2.01	0.08				
	Adults	1.97	0.13	0.84	0.41	−0.06–0.13	0.36
Sprint 30 m (s)	Adolescents	4.97	0.15				
	Adults	4.80	0.32	1.58	0.13	−0.05–0.38	0.68
505—right leg (s)	Adolescents	2.87	0.13				
	Adults	2.81	0.15	1.10	0.28	−0.06–0.19	0.47
505—left leg (s)	Adolescents	2.91	0.21				
	Adults	2.81	0.14	1.26	0.22	−0.06–0.26	0.54

Note: SLDJ = single-leg drop jump, SLCMJ = single-leg countermovement jump, SLH = single-leg hop.

4. Discussion

The aim of this study was twofold: (a) to provide a picture of potential lower limb jumping asymmetries in adolescent and adult female soccer players and (b) to examine the correlation of asymmetries with the female players' performance in 10 m and 30 m sprint and change-of-direction speed. The results of this study showed greater asymmetries in vertical jump tests compared to horizontal jump tests, confirming the initial hypothesis. No statistically significant differences were found in the mean values between adolescent and adult female soccer players for all the variables measured. Adult female soccer players showed a significant positive correlation (r = 0.68, $p < 0.05$) of asymmetry in single-leg hop for distance with speed time in change-of-direction on the right leg (for all adult soccer players, the preferred leg was the right one), suggesting that greater asymmetries in horizontal jumps increased speed time in change-of-direction on the preferred leg, partially confirming the second hypothesis. No significant correlations were found between asymmetries from vertical jump tests and linear or change-of-direction speed time for any group.

Asymmetry values observed in the three types of jump tests were at the level of 19.2% for the SLDJ, 11.2% for the SLCMJ and 6.8% for SLH for distance, in adolescent female soccer players. The corresponding asymmetry values in adult female soccer players were greater for all types of jumps (20.6%, 18.6% and 8%); however, these differences were not statistically significant. The greater asymmetries that occurred in vertical jumps than in horizontal jumps are consistent with the findings of previous studies of pre-adolescent and adolescent female soccer players [15,30], suggesting that vertical jumps are likely to be more sensitive when detecting asymmetry. These differences may be explained by the fact that children are practiced, through game-based activities, at the contents of horizontal jumps (e.g., hopscotch) from an early age [41,42], whereas the motor patterns of single-leg vertical jumps are performed at a lower frequency [15]. However, more studies are needed to support this theory. In addition, the observation that adult female soccer players showed an increased tendency to display asymmetries, in vertical and horizontal jumps, may be explained by the fact that the existence of asymmetries is likely to be due to participation in the same sport for several years [9,10], noting that adult female soccer players have received more specialized training stimuli than their younger counterparts. It is worth noting that asymmetry values found in the present study for vertical and horizontal jumps, in adolescent female soccer players, are in line with those reported in studies with a similar sample [15,30,43–45]. In only two studies [43,44], the level of asymmetry observed in horizontal jump tests for adolescent female soccer players was lower than those recorded in the present study. In adult female soccer players, the level of asymmetry found in our study, for vertical and horizontal jump tests, was much higher (two to three times higher) than the findings of other studies [28,29,46] with adult female soccer players.

Furthermore, in our study, we did not find a statistically significant correlation of asymmetries from vertical and horizontal jump test with time in linear and change-of-direction speed in adolescent female soccer players (Table 1). In a previous study [30] with adolescent female soccer players, asymmetries from vertical and horizontal jump tests did not show statistically significant correlations with linear and change-of-direction speed times. This observation is in agreement with the findings of the present study. In contrast, in another study [15] with prepubescent female soccer players, greater asymmetries from the SLCMJ test increased speed times over distances of 5 m to 20 m, while no correlation was observed between asymmetries from horizontal jump tests and speed times. It is worth noting that, although the level of asymmetries in the SLCMJ is almost the same (11–12%) for the present study and the two previous studies reported [15,30], these asymmetries seem to reduce speed performance in only prepubescent female soccer players [15]. This fact, this may be explained by the different levels of maturity, training ages and competitive levels of the adolescent female soccer players who participated in our study and those who participated in the study by Pardos-Mainer et al. [30]. Moreover, a significant correlation was noted between asymmetry in the SLCMJ test and asymmetry in the SLDJ test, whereas correlations in asymmetry between vertical and horizontal jump tests were absent (Table 3). These findings are in accordance with both studies noted previously [15,30], as no significant correlation was observed between asymmetry in vertical and horizontal jumps, whereas a significant correlation between asymmetries in two types of horizontal jump tests was found [15]. Thus, it seems that asymmetries in jump tests performed in the same direction may show correlations, in contrast to jump tests performed in different directions, in which significant correlations may be absent.

According to the results of our study, adult female soccer players showed a significant positive correlation ($r = 0.68$, $p < 0.05$) of asymmetry in SLH test for distance with the time in change-of-direction speed on the right leg. This suggests that performance in change-of-direction on the right leg decreased as asymmetries from horizontal jumps increased. There was no other significant correlation of jumping asymmetry variables with linear and change-of-direction speed times. The findings in Loturco et al. [29], who noted that asymmetries from vertical jump tests do not seem to impair linear and change-of-direction speed times, are in agreement with the results of our study. However, in Loturco et al.'s [29] other study, elite professional female soccer players participated, and a different test to assess change-of-direction speed time was used.

In contrast, in a previous study [28] of adult female soccer players, asymmetries in the SLDJ test showed to increase speed times at 30 m and in change-of-direction tests, whereas asymmetries in the SLCMJ test did not show a significant correlation with speed times. It is worth noting that the study by Bishop et al. [28] took place during the pre-season, while our study was conducted during the in-season. The importance of this observation would be based on another study [47], according to which asymmetries from the SLDJ test increased linear and change-of-direction speed times in young adult soccer players, only at the end of the season, while no decrease in performance was observed in the pre-season period or in the middle of the in-season. This suggests that these SLDJ asymmetries do not show a consistent impact on performance in speed times over the whole soccer season. In addition, similar to the adolescent female soccer players was the picture observed among the asymmetries in jump tests for adult female soccer players. Specifically, significant correlations between asymmetry from vertical and horizontal jump tests were absent, whereas a moderate correlation between asymmetry in the two types of vertical jump tests was observed, which, however, was not statistically significant (Table 4).

In the linear regression model used in the present study, when the asymmetries from vertical and horizontal jump tests in adult female soccer players were taken into account as independent variables, they were able to explain 73% of the variance in change-of-direction speed performance on the right leg. In other words, the combination of asymmetries from vertical and horizontal jump tests may provide useful insights when explaining the variance in change-of-direction speed performance on the right leg in adult female soccer players. In contrast, the combination of asymmetries from vertical and horizontal jump tests failed to adequately explain the performance in any of the linear and change-of-direction speed tests performed in adolescent female soccer players.

Adolescent and adult female soccer players from the first and second division of the women's soccer in Greece took part in this study. Therefore, caution is recommended in transferring the results of our study to other populations or to other levels of female soccer players (e.g., elite professional female soccer players). This study has certain limitations. In particular, a limitation of the study is the small number of participants, due to the limited availability of female soccer players based on the inclusion criteria of the study (age, level of competition, training age, absence of injuries and participation in at least three training sessions per week). Also, the small sample size constitutes a limitation for the regression analysis. However, it was chosen for analysis as it could present possible trends. In addition, it was not possible to conduct the same measurements in the pre-season period and at the end of the in-season, which would have provided a more complete picture of the correlations between asymmetries and performance in linear and change-of-direction speed tests. In this way, it would have been examined whether a possible reduction in asymmetries might favor performance on variables that were previously negatively affected by asymmetry detection. Bishop et al. [47] suggest that the practice of assessing asymmetries with vertical jump tests is not recommended for monitoring performance in linear and change-of-direction speed in elite male academy players. However, in our opinion, it is worth investigating whether the systematic assessment of asymmetries shows the same indications in female soccer players. Moreover, we suggest examining the correlation of not only vertical but also horizontal jumping asymmetries with the performance of female soccer players, in a systematic way. To conclude, we suggest practitioners implement strength and power training programs [44,46,48], as well as injury prevention protocols (FIFA 11+), balance training and neuromuscular training [49–51], aiming to reduce asymmetries in order to minimize the risk of injuries and potentially improve the performances of female soccer players in certain fitness tests.

5. Conclusions

To our knowledge, the present study is the first to provide an overview of jumping asymmetries from vertical and horizontal jump tests in adolescent and adult female soccer players in Greece. Adult female soccer players showed higher asymmetry values in vertical and horizontal jumps, but these differences were not statistically significant. While asymmetries in vertical jumps do not seem to have a significant impact on female soccer players' speed times, asymmetries in horizontal jumps seem to impair change-of-direction speed performance only in adult female soccer players, on the contrary to the adolescents, who seem to remain unaffected. Furthermore, asymmetries in jump tests conducted in the same direction seem to be correlated, while this is not the case for asymmetries in jump tests performed in different directions. In conclusion, it is suggested that the regular evaluation of female soccer players with single-leg jump assessments conducted in multiple directions can provide useful insight into asymmetry detection, performance in change-of-direction speed time and inform practitioners about individual needs of the players. Finally, it is worth noting that jump assessments represent a time-efficient method [3] that can be implemented in the routine of soccer teams.

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Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Institutional Review Board of the Exercise Physiology and Sport Rehabilitation Laboratory, Thessaloniki, Greece (No. 04/2022 approved 27 October 2022).

Informed Consent Statement: Informed consent was obtained from all subjects involved in this study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Conflicts of Interest: The authors declare no conflicts of interest.

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