Correlation of Single-leg Jump Asymmetries and Speed of Change of Direction at Multiple Angles in Female Athletes

Aishwarya Deshpande[1] Sarika Chaudhary[2*], Varsha Parmar[3]

[1](MPT Sports), Sports Physiotherapist, Heartfulness Gopichand Badminton Academy, Hyderabad, India.

[2]Associate Professor. MYAS-GNDU Department of Sports Sciences & Medicine, Guru Nanak Dev University, Amritsar, Punjab, India.

[3]Research Scholar, MYAS-GNDU Department of Sports Sciences & Medicine, Guru Nanak Dev University, Amritsar, Punjab, India.

ABSTRACT

Background: During Multidirectional sprinting, linear speed is typically affected by lower-limb power, but its influence on change-of-direction speed remains less clear. These athletes are prone to develop asymmetric adaptations due to unilateral actions, potentially affecting performance and injury risk. The present study aims to explore the association between single-leg jump asymmetries and the speed of change of direction at multiple angles in female athletes.

Material and Methods: In this cross-sectional study, 42 young female team sport athletes aged between 18 and 24 years, actively participating in sports with a history of at least one year of training, were included in the study. Athletes with recent lower limb injury, surgery or any medical condition impeding the study were excluded. athletes were asked to perform Single-leg countermovement jump, vertical, horizontal, and lateral jumps, along with 10m linear sprints and change of direction tests.

Result: The data were analysed using IBM SPSS Statistics (Version 27.0, IBM Corp, Armonk, NY, USA). Pearson's correlation was established between single-leg countermovement jump-lateral asymmetries and change of direction deficit at 45° and 180° angles. No significant correlation was observed between jump asymmetries and change of direction at multiple angles.

Conclusion: The present study concluded that interlimb asymmetry does not have any influence over the change of direction ability of female team sports athletes.

Keywords: Change of Direction Speed, Leg Asymmetries, Single-leg Countermovement Jump, Team sports.

Address of Corresponding Author

Dr. Sarika Chaudhary; MYAS-GNDU Department of Sports Sciences & Medicine, Guru Nanak Dev University, Amritsar, Punjab, India.

E-mail: sarikamyas@gmail.com

Crossref Doi: https://doi.org/10.36437/irmhs.2026.9.2.B

Introduction

Leg Power is an essential part of the built of athletes in team sports like football, hockey, handball, volleyball, etc.[1] It should be exhibited in their running patterns.[2] However, it is also crucial to note that these athletes must be able to sprint in multiple directions, accelerate, reverse or quickly and effectively change direction and re-accelerate.[3,4]

Multiple-direction sprinting ability includes both linear and change-of-direction (COD) speed.[5] Linear speed encompasses running at maximum speed in a straight line, while change-of-direction speed combines rapid acceleration, deceleration, and direction changes, all of which are integral to agility. It has been previously stated that leg power is essential for both linear speed and COD speed.[1,3] However, the COD test was used because, in evaluating agility, only assessments involving spontaneous action-reaction tasks are conducted, whereas in assessing change-of-direction (COD) performance, tests use pre-planned actions.[6] In team sports, the results of games are greatly impacted by vigorous unilateral movements such as jumping and changes of direction (COD).[7] Hence, professionals and researchers are continually investigating more efficient ways to optimize an athlete's ability to accelerate and re-accelerate.[7] These intense unilateral movements often lead athletes in team sports to develop asymmetrical neuromuscular adaptations in their lower limbs.[8] Asymmetry is the difference in performance of the lower limb on specific tests.[9] It has been previously reported that, asymmetries in lower limb power may detrimentally affect athletic performance.[10] Even though the association between asymmetries and change of direction skills is not fully understood.[11,12] Due to the unpredictable nature of agility requirements, it seems logical that in sports necessitating multidirectional movement, having equal proficiency and speed in changing direction from both limbs would be advantageous.[13]

In recent times, a novel concept (COD deficit) has emerged as a suitable approach for evaluating change of direction ability[14] in several team sports such as soccer[15], handball[4], basketball[16] or netball.[13] The COD deficit calculates the extra time needed to execute a change in direction compared to covering the same distance.[14] Likewise, Frietas et al (2018) described the COD deficit as the difference in time required to complete the linear sprint and a COD task of equal distance.[17] As a result, COD deficit time is suggested to offer a more precise gauge of an athlete's genuine change of direction (COD) capability, enabling a more focused measurement that is less affected by the athlete's linear sprint velocity.[14]

Hence, given that the unilateral jumping does provide an indication of lower limb function, there is limited research that has documented the influence of leg power asymmetries as measured through jump performance on change-of direction sprinting. Also, empirical studies surrounding the use of COD deficit to calculate lower limb asymmetry in young female athletes are scarce; further research in this area is warranted. Research is required to quantify the COD deficit using different COD angles, such as 45˚, 90˚ or 135˚, and comparing asymmetries from different team-sports athletes and genders.[18] Furthermore, the COD deficit can also be used for calculating lower-limb neuromuscular asymmetries. However, despite the current Popularity of this concept[16], a few Studies have analysed lower-limb asymmetries using this phenomenon.

Methodology

In this cross-sectional study, a sample size of 42 participants was selected on the basis of specific inclusion and exclusion criteria. The study was carried out after the approval of the Institutional Ethical Committee of Guru Nanak Dev University, Amritsar, Punjab (1417/HG dated 27/03/2023). The sample consisted of female athletes aged between 18 and 24 years actively engaged in sports such as football, hockey, and Handball with a minimum one-year history of training. Female athletes with recent lower limb injury, surgery or medical conditions impeding study participation. The variables investigated were: unilateral jump performance, encompassing vertical single-leg counter-movement jump height, horizontal and lateral counter-movement jump distances, as well as 10-meter linear sprint speed and change of direction speed. The study was carried out at the MYAS-GNDU Department of Sports Sciences and Medicine, funded by the Ministry of Youth Affairs and Sports, Government of India.

Procedure

One week prior to data collection, participants underwent a familiarization session to acquaint themselves with the testing protocols, allowing them to practice each test between 2 and 5 times. Prior to the commencement of data collection, all participants engaged in a 10-minute warm-up, consisting of light jogging and dynamic stretches focusing on the lower body, such as multidirectional lunges, inchworms, bodyweight squats, and core activation exercises. Following the warm-up, participants were reintroduced to the testing procedures and were given up to three practice attempts for each task. Data collection involved recording two valid trials per limb, as specified for each task. Each trial was separated by a 60-second recovery period.

Single leg Countermovement Jump (Fig.1,2)

Participants completed two successful trials on each leg for three types of single-leg countermovement jumps (SLCMJ): vertical (SLCMJ-V), horizontal (SLCMJ-H), and lateral (SLCMJ-L). They were instructed to stand on one leg, perform a countermovement, and then explosively extend the stance leg to jump as high or as far as possible in the specified direction (vertical, horizontal, or lateral).

Participants were instructed to land on both feet simultaneously, with a successful trial defined by maintaining hands on hips throughout the movement and maintaining balance for at least three seconds upon landing. Jump height in meters was calculated for SLCJ-V, while distances for SLCMJ-H and SLCMJ-L were measured in meters using a measuring tape fixed to the floor, starting from a designated starting line. These tasks have demonstrated good test-retest reliability.

Figure 1. Single leg countermovement jump-vertical.

Figure 2. Single leg countermovement jump –lateral.

Change of Direction Test (Figure.3,4)

Each trial involved sprinting 5 meters toward a cone, changing direction around it, then sprinting another 5 meters to the endpoint. Four conditions were tested: straight-line running and making cuts of 45°, 90°, 135°, and 180°.[19] Athletes were instructed to complete each change of direction (COD) run in the shortest total time possible. In the first attempt, athletes could start with any limb placed forward. In the second attempt, they were required to start with a different limb placed forward. The participants were given one attempt at each condition, but in case of violations of the test requirements, one extra attempt could be performed.

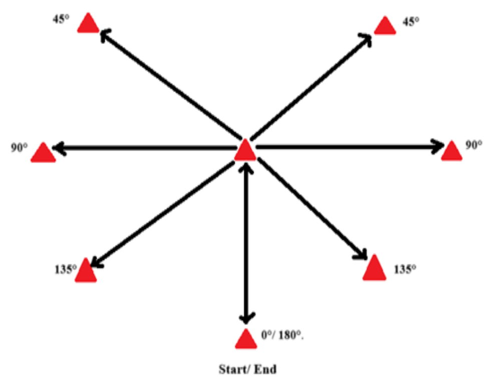

Figure 3. Demonstrative model of Change of direction test.

Figure 4. Change of direction test.

10 m linear Sprint Test

Sprint speed was assessed using a 10-meter sprint test. Clearly marked cones indicated the start and finish lines. Participants positioned their front foot 0.5 meters before the first timing gate. Each player performed two sprints, with a three-minute rest period between each sprint. The faster time of the two sprints was selected for subsequent analysis.

Result

Forty-two female team sport athletes of mean age (19.97±1.94 years), weight (57.06±3.67 kg), height (1.62±0.04 m), and BMI (21.82± 1.81 kg/m2) underwent the procedure. Descriptive statistics, Mean, and SD of the data were calculated. The data was analyzed using SPSS, and normality of the variables was assessed using the Shapiro-Wilk test. As the data followed a normal distribution, Pearson's test was applied to find out the correlation between the variables.

Lateral Countermovement jump asymmetry is somewhat correlating with COD deficit at 45o and 180o. However, no significant correlation could be established with horizontal and vertical countermovement jump asymmetries and COD deficits at any angle.

Asymmetries in countermovement jump performance in all 3 directions did not correlate with COD speed at any of the 4 angles.

	COD deficit 45 ° – L (0.33±0.26)		COD deficit 45 ° – R (0.31±0.27)		COD deficit 90 ° – L (0.68±0.37)		COD deficit 90 ° – R (0.74±0.27)	
	r- value	p- value	r- value	p- value	r- value	p-value	r- value	p-value
SLCMJ-H Asymmetry (5.22±4.40)	-0.029	0.852	-0.184	0.263	-0.084	0.591	-0.140	0.368
SLCMJ-L Asymmetry (5.48±4.14)	0.417	**0**.005	0.225	0.145	0.093	0.550	0.095	0.543
SLCMJ-V Asymmetry (3.08±3.51)	-0.002	0.988	0.029	0.852	0.139	0.371	0.137	0.379

Table 1: Shows correlation between COD deficit and Jump asymmetries at 45 ° and 90 °

	COD deficit 135 ° – L (1.01±0.38)		COD deficit 135 ° – R (1.01±0.37)		COD deficit 180 ° – L (1.37±0.40)		COD deficit 180 ° – R (1.39±0.33)	
	r- value	p- value	r- value	p- value	r- value	p-value	r- value	p-value
SLCMJ-H Asymmetry	-0.129	0.406	-0.034	0.826	-0.134	0.396	0.009	0.950
SLCMJ-L Asymmetry	0.208	0.179	0.254	0.100	0.317	0.038	0.268	0.081
SLCMJ-V Asymmetry	-0.031	0.840	0.020	0.895	-0.127	0.413	0.072	0.642

Table 2: Shows correlation between COD deficit and Jump asymmetries at 135° and 180°.

	COD L45° (3.19±0.28)		COD R45° (3.18±0.29)		COD L 90° (3.55±0.41)		COD R 90° (3.61±0.32)	
	r- value	p- value	r- value	p- value	r- value	p- value	r- value	p- value
SLCML- H Asymmetry	0.061	0.695	-0.042	0.783	-0.108	0.488	0.006	0.965
SLCMJ- L Asymmetry	0.264	0.086	-0.026	0.864	0.126	0.419	-0.024	0.877
SLCMJ- V Asymmetry	0.104	0.503	0.230	0.137	0.101	0.516	0.210	0.175

Table 3: Shows correlation between SLCMJ asymmetries and COD speed at 45° and 90°.

	COD L135° (3.88±0.35)		COD R135° (3.88±0.36)		COD L 180° (4.23±0.38)		COD R 180° (4.25±0.35)	
	r- value	p- value	r- value	p- value	r- value	p- value	r- value	p- value
SLCML- H Asymmetry	-0.067	0.667	0.034	0.827	-0.074	0.636	0.080	0.608
SLCMJ- L Asymmetry	0.127	0.413	0.165	0.288	0.242	0.116	0.159	0.307
SLCMJ- V Asymmetry	0.052	0.739	0.104	0.503	-0.053	0.734	0.155	0.319

Table 4: Shows Correlation between SLCMJ asymmetries and COD speed at 135° and 180°.

Discussion

Although the unilateral jump performance is considered as a crucial component of the multi-directional sprinting ability of team-sport athletes, it has not received extensive examination in current literature. The potential impact of between-leg asymmetries, as determined by unilateral jumping, on multidirectional speed has not been thoroughly explored. Neuromuscular imbalances have the potential to lead to muscular and joint injuries in team sports, particularly in the lower limbs.[10] Therefore, this study aimed to investigate the influence of unilateral leg power, assessed through single-leg jump tests (vertical, horizontal, and lateral), and between-leg jump asymmetries on performance in a 10-meter sprint, both in straight lines and at angles of 45°, 90°, 135°, and 180°. The findings suggested that asymmetry in lateral countermovement jumps was somewhat associated with a deficit in change of direction (COD) at 45° and 180° angles (Table 1,2). However, no significant correlation was found between asymmetries in horizontal and vertical countermovement jumps and COD deficits at any angle. Asymmetries in countermovement jump performance in all 3 directions did not correlate with COD speed at any of the angles (Table 3,4). Correlation analyses are subject to limitations, as factors including body mass, physique, flexibility, technique, and leg strength of the subjects can influence the statistical models generated. The interaction between physiological and technical factors would have impacted the study results. Similar findings were observed by Lockie et al. (2014); they stated in their study that asymmetries, as measured by between-leg differences in jump performance in the 3 different planes of motion, did not seem to significantly relate to multidirectional speed.[12]

Our results are somewhat in line with previous similar studies. Bishop et al. (2021a) explored the impact of asymmetry observed in the hop test on change of direction performance. This study, conducted on college-level athletes across different sports, revealed no associations between asymmetries and performance in the COD test.[20] Pardos-Mainer et al. (2021) studied the impact of asymmetries among female soccer players across three age groups (U18, U16, U14) on physical performance tests; it was found that the asymmetries identified in jump tests did not influence the outcomes of the change of direction (COD) tests.[21] Lockie et al. (2014) demonstrated that jump height and distance asymmetries ranging from 3.3% to 10.4% did not correlate with speed or change of direction speed (CODS) performance.[12] Dos'Santos et al. (2017) similarly found no relationship between distance asymmetries from single- and triple-hop tests and CODS performance across two different tasks.[11] Struzik et al. (2017) investigated 12-year-old soccer players and found no significant associations between counter-movement jumps (CMJ) and CODs during sprints.[25]

In contrast, Michailidis et al. (2020) observed a correlation between lower limb asymmetry (measured by SLCMJ) and performance on the 505 test in U15 soccer players, though not with the Arrowhead test.[22] Specifically, SLCMJ asymmetries were linked to slower performance on the 505 COD test. Madruga-Parera et al. (2020) reported that asymmetries in jump height and distance were associated with decreased performance in jumping, change of direction speed (CODS), and repeated sprint tests, but not in linear speed.[23] Bishop et al (2021a), mentioned that asymmetry among male soccer players led to diminished physical performance during change of direction.[24] Maloney et al. (2017) demonstrated that asymmetries in jump height (measured by unilateral drop jump) were linked to slower change of direction speed (CODS) performance, but not with jump performance.[8] The conflicting findings underscore the importance of carefully selecting tests to evaluate asymmetries based on factors such as age, gender, sport, and position. However, besides our study, there is limited significant data available on the relationship between unilateral jump asymmetries and COD ability across multiple angles (45°, 90°, 135°, and 180°).

The main limitation of the present investigation was its cross-sectional nature, which precluded the determination of any causal relationship between the different variables. Further research is required to analyze the difference according to the athletes' standard and their role in the game, because of the athletes' physical and physiological characteristics as well as playing positions. Besides, the results of this research are only representative of the time the tests were carried out (end of the season) and, therefore, may fluctuate at different points throughout the season. For this reason, further research is needed to compare the magnitude and direction of asymmetry over a longer time period.

Conclusion

It can be concluded that interlimb asymmetry does not have any influence over change of direction ability of female team sports athletes. Although these asymmetries do not affect the change of direction performance of athletes but bilateral strength and power training is required to prevent injuries.

References

1. Lockie RG, Murphy AJ, Knight TJ, Janse de Jonge XA. Factors that differentiate acceleration ability in field sport athletes. J Strength Cond Res. 2011 Oct;25(10):2704-14. doi: https://doi.org/10.1519/jsc.0b013e31820d9f17
2. Mero A, Komi PV, Gregor RJ. Biomechanics of sprint running. A review. Sports Med. 1992 Jun;13(6):376-92. doi: https://doi.org/10.2165/00007256-199213060-00002
3. Young W, Farrow D. A review of agility: practical applications for strength and conditioning. Strength Cond J. 2006 Oct;28(5):24-29. doi: https://doi.org/10.1519/00126548-200610000-00004
4. Pereira LA, Nimphius S, Kobal R, Kitamura K, Turisco LA, Orsi RC, et al. Relationship between change of direction, speed, and power in male and female national olympic team handball athletes. J Strength Cond Res. 2018 Oct;32(10):2987-2994. doi: https://doi.org/10.1519/jsc.0000000000002494
5. Lockie RG, Schultz AB, Jeffriess MD, Callaghan SJ. The relationship between bilateral differences of knee flexor and extensor isokinetic strength and multi-directional speed. Isokinetics Exerc Sci. 2012;20(3):211-9. doi: https://doi.org/10.3233/IES-2012-0461

6. Falces-Prieto M, González-Fernández FT, García-Delgado G, Silva R, Nobari H, Clemente FM. Relationship between sprint, jump, dynamic balance with the change of direction on young soccer players' performance. Scientific Reports. 2022 Jul 18;12(1):12272. doi: https://doi.org/10.1038/s41598-022-16558-9
7. Loturco I, Pereira LA, Freitas TT, Alcaraz PE, Zanetti V, Bishop C, et al. Maximum acceleration performance of professional soccer players in linear sprints: Is there a direct connection with change-of-direction ability? PLoS One. 2019 May 7;14(5):e0216806. doi: https://doi.org/10.1371/journal.pone.0216806
8. Maloney SJ, Richards J, Nixon DG, Harvey LJ, Fletcher IM. Do stiffness and asymmetries predict change of direction performance? J Sports Sci. 2017 Mar;35(6):547-56. doi: https://doi.org/10.1080/02640414.2016.1179775
9. Keeley DW, Plummer HA, Oliver GD. Predicting asymmetrical lower extremity strength deficits in college-aged men and women using common horizontal and vertical power field tests: a possible screening mechanism. J Strength Cond Res. 2011;25(6):1632-7. Doi: https://doi.org/10.1519/jsc.0b013e3181ddf690
10. Arboix-Alió J, Buscà B, Busquets A, Aguilera-Castells J, de Pablo B, Montalvo AM, Fort-Vanmeerhaeghe A. Relationship between inter-limb asymmetries and physical performance in rink hockey players. Symmetry. 2020 Dec 9;12(12):2035. doi: https://doi.org/10.3390/biology11060812
11. Dos'Santos T, Thomas C, Jones PA, Comfort P. Asymmetries in single and triple hop are not detrimental to change of direction speed. Journal of Trainology. 2017 Jun 17;6(2):35-41. doi: https://doi.org/10.17338/trainology.6.2_35
12. Lockie RG, Callaghan SJ, Berry SP, Cooke ER, Jordan CA, Luczo TM, et al. Relationship between unilateral jumping ability and asymmetry on multi-directional speed in team-sport athletes. J Strength Cond Res. 2014;28(12):3557-66. doi: https://doi.org/10.1519/jsc.0000000000000588
13. Dos' Santos T, Thomas C, Jones PA, Comfort P. Assessing asymmetries in change of direction speed performance: Application of change of direction deficit. The Journal of Strength & Conditioning Research. 2019 Nov 1;33(11):2953-61. doi: https://doi.org/10.1519/jsc.0000000000002438
14. Nimphius S, Callaghan SJ, Spiteri T, Lockie RG. Change of direction deficit: a more isolated measure of change of direction performance than total 505 time. J Strength Cond Res. 2016 Nov;30(11):3024-32. doi: https://doi.org/10.1519/jsc.0000000000001421
15. Loturco I, Nimphius S, Kobal R, Bottino A, Zanetti V, Pereira LA, et al. Change-of direction deficit in elite young soccer players. Ger J Exerc Sport Res. 2018;48(2):228-234. doi: https://doi.org/10.1007/s12662-018-0502-7
16. Thomas TDC, Comfort P, Jones PA. Comparison of change of direction speed performance and asymmetries between team-sport athletes: application of change of direction deficit. Sports (Basel). 2018 Dec 10;6(4):174. doi: https://doi.org/10.3390/sports6040174
17. Freitas TT, Pereira LA, Alcaraz PE, Arruda AFS, Guerriero A, Azevedo PHSM, et al. Influence of strength and power capacity on change of direction speed and deficit in elite team-sport athletes. J Hum Kinet. 2019;68:167–76. doi: https://doi.org/10.2478/hukin-2019-0069
18. Arboix-Alió J, Bishop C, Benet A, Buscà B, Aguilera-Castells J, Fort-Vanmeerhaeghe A. Assessing the magnitude and direction of asymmetry in unilateral jump and change of direction speed tasks in youth female team-sport athletes. Journal of human kinetics. 2021 Jul 28;79:15. doi: https://doi.org/10.2478/hukin-2021-0061
19. Marques JB, Paul DJ, Graham-Smith P, Read PJ. Change of direction assessment

following anterior cruciate ligament reconstruction: a review of current practice and considerations to enhance practical application. Sports Med. 2020 Jan;50(1):55-72. doi: https://doi.org/10.1007/s40279-019-01189-4

20. Bishop C, Lake J, Loturco I, Papadopoulos K, Turner A, Read P. Interlimb asymmetries: The need for an individual approach to data analysis. The Journal of Strength & Conditioning Research. 2021 Mar 1;35(3):695-701. doi: https://doi.org/10.1519/jsc.0000000000002729
21. Pardos-Mainer E, Lozano D, Torrontegui-Duarte M, Cartón-Llorente A, Roso-Moliner A. Effects of strength vs. plyometric training programs on vertical jumping, linear sprint and change of direction speed performance in female soccer players: a systematic review and meta-analysis. Int J Environ Res Public Health. 2021 Jan 7;18(2):401. doi: https://doi.org/10.3390/ijerph18020401
22. Michailidis Y, Savvakis C, Pirounakis V, Mikikis D, Margonis K, Metaxas T. Association between jump asymmetry and reduced performance in the change of direction tests of youth soccer players. J Phys Educ Sport. 2020;20(3):1362-8. doi: https://doi.org/10.7752/jpes.2020.03188
23. Madruga-Parera M, Bishop C, Read P, Lake J, Brazier J, Romero-Rodriguez D. Jumping-based asymmetries are negatively associated with jump, change of direction, and repeated sprint performance, but not linear speed, in adolescent handball athletes. J Hum Kinet. 2020 Jan;71:47-58. doi: https://doi.org/10.2478/hukin-2019-0095
24. Bishop C, Brashill C, Abbott W, Read P, Lake J, Turner A. Jumping asymmetries are associated with speed, change of direction speed, and jump performance in elite academy soccer players. The Journal of Strength & Conditioning Research. 2021 Jul 1;35(7):1841-7. doi: https://doi.org/10.1519/jsc.0000000000003058
25. Struzik A, Winiarski S, Popowczak M, Rokita A. Relationships between variables describing vertical jump and sprint time. S Afr J Res Sport Phys Educ Recreat. 2017;39(1):177-88. https://www.researchgate.net/profile/Artur-Struzik/publication/317175092_Relationships_between_variables_describing_vertical_jump_and_sprint_time/links/592eb48d0f7e9beee741f0ef/Relationships-between-variables-describing-vertical-jump-and-sprint-time.pdf

How to cite this Article: Deshpande. A, Chaudhary. S, Parmar. V; Correlation of Single-leg Jump Asymmetries and Speed of Change of Direction at Multiple Angles in Female Athletes; Int. Res. Med. Health Sci., 2026; (9-2): 11-19; doi: https://doi.org/10.36437/irmhs.2026.9.2.B

Source of Support: Nil, **Conflict of Interest:** None declared.

Received: 11-03-2026; **Revision:** 15-05-2026; **Accepted:** 23-05-2026