International Journal of Sociologies and Anthropologies Science Reviews
Volume 4 Issue 1: January -February 2024: ISSN 2985-2730
Website: https://so07.tci-thaijo.org/index.php/IJSASR/index
DOI: https://doi.org/10.60027/ijsasr.2024.3702

# Reducing Limb Asymmetry in Females Collegiate Basketball: A Randomized Trial

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Received 06/10/2023 Revised 14/10/2023 Accepted 20/10/2023

**Abstract**

**Background and Aim:** Interlimb strength asymmetry has garnered significant attention in the field of sports science for its potential to influence both athletic performance and injury risk. Despite this, there is a noticeable gap in the literature concerning its impact on elite female collegiate basketball players. The study aims to assess the effectiveness of targeted weaker limb strength training in reducing jump strength asymmetry among elite female college basketball players.

**Materials and Methods:** A randomized controlled design was used, involving 24 elite female college basketball players from Guangzhou Sports University. The Experimental Group underwent specialized training for the weaker limb, while the Control Group followed balanced training. The primary outcome was the change in the maximum ground reaction force (GRF) during single-leg jumps. Linear Mixed-Effects models were used for statistical analysis, with a two-tailed significance level of $p<0.05$.

**Result:** The intervention was effective in reducing Countermovement Jump Asymmetry and Horizontal Jump Asymmetry with statistical significance (p-values 0.0045 and 0.029, respectively) but did not significantly impact Lateral Jump Asymmetry (p-value 0.2733). These findings were consistent when comparing the Experimental and Control groups post-intervention (p-values 0.0055 and 0.0474 for Countermovement and Horizontal, respectively; 0.3995 for Lateral). Time and group interaction analyses were significant but not universally consistent across all measures after the Bonferroni correction. Overall, the intervention had a mixed but generally positive effect on jump asymmetry.

**Conclusion:** The study demonstrates that targeted weaker limb strength training can effectively reduce jump strength asymmetry in elite female collegiate basketball players. These findings have implications for athletic training regimens aimed at both improving performance and reducing the risk of injury.

**Keywords:** Interlimb Strength Asymmetry; Ground Reaction Force; Countermovement Jump; Basketball Training; Elite Female Athletes

## Introduction

Interlimb strength asymmetry has garnered significant attention in the field of sports science for its potential to influence both athletic performance and injury risk. Despite this, there is a noticeable gap in the literature concerning its impact on elite female collegiate basketball players, particularly within the context of Guangzhou Sports University. Preliminary observations and internal assessments at Guangzhou Sports University have indicated that female basketball players frequently exhibit jumping strength asymmetries, which might compromise both their athletic performance and susceptibility to injuries. This situation underscores an immediate need for targeted interventions in this demographic to address such asymmetries.

Basketball as a sport places unique demands on lower extremity capabilities, thereby necessitating a deeper understanding of how limb strength asymmetry could affect performance and injury susceptibility in female collegiate athletes. Previous research has underscored the negative consequences of interlimb strength asymmetry on key performance metrics such as jumping and sprinting (Philipp et al., 2020; Boccia et al., 2018). However, these studies often produce inconsistent results, and the field lacks a universally accepted threshold to determine what level of asymmetry is "problematic" (Dos'Santos, 2020; Bettariga et al., 2022). Further complicating the matter is the absence of standardized methodologies for evaluating interlimb strength asymmetry, an issue that hinders cross-study comparisons and undermines the development of evidence-based interventions (Bishop et al., 2023; Chen et al., 2023).

To bridge these gaps, the present study is designed with a specific focus: to evaluate the efficacy of targeted weaker limb strength training on jump strength asymmetry among elite female college


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basketball players at Guangzhou Sports University. Utilizing a randomized controlled design, this research will involve 24 athletes from the university, who will be assigned to an Experimental Group (EG) or a Control Group (CG). The EG will undergo specialized training aimed at amplifying the strength of the weaker limb, while the CG will adhere to a balanced training approach. The primary outcome metric will be the change in the maximum ground reaction force (GRF) during single-leg jumps, captured before and after the 6-week intervention period. This study not only seeks to establish whether targeted training can mitigate interlimb strength asymmetry but also aspires to provide actionable insights that could guide future training programs and injury prevention strategies specifically tailored for the elite female basketball players of Guangzhou Sports University."

**Objectives**

To evaluate the effects of targeted weaker limb strength training on jump strength asymmetry in basketball players of Guangzhou Sports University.

**Literature Review**

*1. Interlimb Strength Asymmetry: Impact on Performance and Injury Risk*

In the domain of sports science, the construct of interlimb strength asymmetry has received substantial attention, specifically for its ability to influence athletic performance and predisposition to injury, with a particular focus on jump strength. A cadre of empirical studies has been aimed at elucidating this intricate relationship.

Bishop et al. (2021) investigated the repercussions of jumping asymmetry in elite soccer players, finding associations with speed and change of direction speed. However, curiously, the study did not corroborate these findings in jump-specific tests. This raises questions about the specificity and transference of asymmetry effects across different performance indicators. Philipp et al. (2020) extended this discourse, emphasizing that interlimb asymmetry could indeed have a deleterious impact on an athlete's ability to perform key tasks such as jumping and sprinting. However, the study was inconclusive regarding the "critical threshold" at which asymmetry impacts performance, a lacuna echoed by Dos'Santos (2020).

Moreover, the sport-specificity of the impact of interlimb asymmetry is noteworthy. Brassart et al. (2023) focused on wheelchair basketball players, revealing that upper limb asymmetry could hinder performance or increase injury risk, particularly in athletes with lower degrees of impairment. This suggests that the influence of asymmetry might be modulated by the functional status of the athlete. Guan et al. (2023) brought with sharp relief the nebulous findings related to youth athletes in taekwondo, signaling the need for more granular research in this demographic.

Analytically, the divergent findings in these studies indicate that the impact of interlimb strength asymmetry is not only multifactorial but also contingent on the specific athletic context. There exists a glaring need for consensus on operational definitions and meaningful thresholds, as underscored by Bishop et al. (2023) and Dos'Santos (2020). This is vital for the harmonization of future research efforts and the implementation of evidence-based interventions.

In conclusion, the current literature presents a complex tableau of the impact of interlimb strength asymmetry on athletic performance and injury risk. Although certain associations have been substantiated, the field is rife with inconsistencies and undefined parameters. The urgent need now is to address these research gaps, with a particular focus on demographic and sport-specific nuances, to formulate effective strategies for athlete development and injury prevention.

*2. Assessment and measurement approaches*

The assessment of interlimb strength asymmetry has gained considerable attention in sports science, primarily due to its implications for performance optimization and injury prevention. One of the cornerstone metrics for evaluating this asymmetry is the ground reaction force (GRF). Countermovement Jump (CMJ) emerges as a standard tool for gauging lower body asymmetry, offering both ease of administration and insightful data (Janicijevic et al., 2023). Measured on force platforms, the CMJ provides a quantifiable GRF disparity between the limbs, thus serving as a reliable indicator of functional imbalance.



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Another notable methodology incorporates the use of force plates during conventional exercises like back squats (Bishop et al., 2023). Here, GRF serves as the critical output, providing a nuanced understanding of interlimb strength during dynamic, multijoint movements. This approach is particularly enlightening when investigating the functional relevance of such asymmetries in sport-specific tasks.

Furthermore, the Scaling Factor for Force / Torque Development (RFD-SF / RTD-SF) is an emerging tool that focuses on neuromuscular speed (Smajla et al., 2020). Unlike other methods that provide a snapshot of asymmetry, RFD-SF offers a temporal dimension, potentially identifying transient imbalances that might be overlooked in static measurements. Similarly, Symmetry in External Work (SEW) calculates the external work done by each limb during activities such as the ascent and descent of stairs, incorporating GRF and displacement of the center of mass into its algorithm (Agrawal et al., 2013).

These assessment tools are complemented by a range of training protocols designed to attenuate interlimb asymmetry. These include unilateral and bilateral strength training, plyometric exercises, and eccentric strength protocols, which have been shown to produce small to moderate effects in reducing asymmetry (Guan et al., 2023). It is crucial to understand that this asymmetry correlates with an increased risk of injury, particularly in sports like soccer (Boccia et al., 2018; Nicholson et al., 2022).

*3. Intervention strategies and research gaps*

Traditional resistance training has been discussed as a potential modality for reducing lower limb asymmetry (Bathe et al., 2023; Bishop et al., 2023; Gonzalo-Skok et al., 2022). However, the body of research is still limited in both volume and quality, echoing the need for targeted studies. Here lies the relevance of ongoing research efforts such as the randomized controlled trial aimed at elite female college basketball players. This study aims to address the gap by focusing specifically on targeted weaker limb strength training, a topic noticeably absent in the existing literature.

Flywheel resistance training, another intervention, has shown preliminary promise but suffers from the absence of standardized protocols (Bishop et al., 2023). The current research design's emphasis on quantifiable metrics like ground reaction force (GRF) could serve as a foundation for standardizing assessment methods in future studies.

Guan et al. (2023) advocate for combined training interventions, which, although promising, are marred by potential study bias and lack a uniform methodological framework. Furthermore, Bishop et al. (2021) underscores the potential benefits of incorporating unilateral exercises in sports that frequently engage in unilateral actions, such as soccer.

In summary, while several interventions have been proposed, including traditional and flywheel resistance training, as well as combined training methods, the existing literature is fraught with methodological inconsistencies. These gaps further accentuate the need for well-designed, focused studies, such as the proposed research on targeted weaker limb strength training in elite female collegiate basketball players, to provide evidence-based guidelines in this crucial area of sports science.

In summary, the Literature Review serves as the foundational basis for our research framework by identifying critical gaps, inconsistencies, and methodological approaches in the existing literature on interlimb strength asymmetry. Specifically, it illuminates the need for targeted studies on elite female collegiate basketball players and informs our choice of key metrics such as ground reaction force (GRF) and Countermovement Jump (CMJ). The review also highlights existing intervention strategies and their limitations, thereby justifying our research focus on targeted weaker limb strength training. This synthesis of previous work has been instrumental in formulating a research approach designed to contribute empirical evidence addressing the identified gaps in this crucial area of sports science.



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## Conceptual Framework

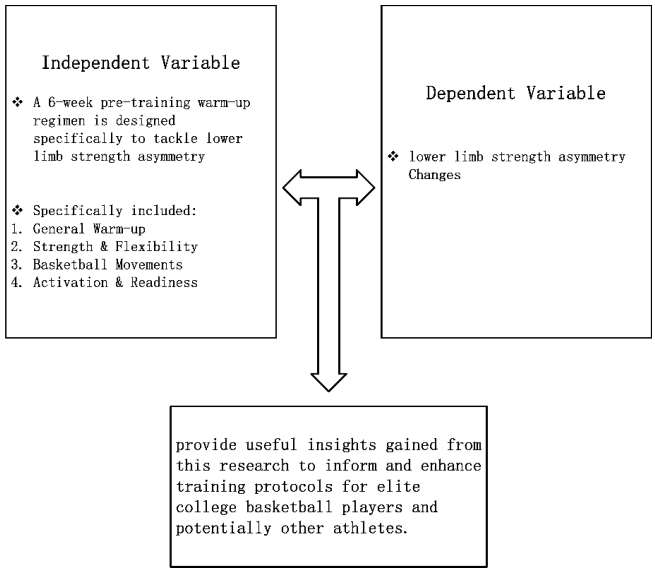


Figure 1. Conceptual framework

## Methodology

### Participants

A total of 24 elite female collegiate basketball players from Guangzhou Sports University, aged 18-22 years, have no current injuries. They participate in team basketball training three times a week, with each session lasting 2 hours. The participants will be evenly divided into two groups: 12 in the intervention group and 12 in the control group. Inclusion Criteria: Participants were selected if they exhibited an interlimb strength asymmetry of at least 10%, as determined by averaging results from three tests: single leg counter-movement jump (CMJ), horizontal jump, and lateral jump. In these tests, the stronger leg consistently yielded a higher peak GRF across all jump types.

### Experimental Design

In this study, a randomized controlled design was used to assess the varying effects of two separate basketball training methodologies in the Experimental Group (EG) and the Control Group (CG). The principal difference between the methodologies was in the warm-up phase. The Experimental Group focused on improving the strength of the weaker limb by performing additional repetitions, aiming to asymmetrically increase the strength of the lower limb. On the contrary, the control group followed a balanced regimen, maintaining equal sets and repetitions for both limbs, reflecting the stronger regimen of the limbs in the experimental group. The hypothesis suggests that after a 6-week intervention, both groups will exhibit improved lower limb strength, with more significant improvements observed in the weaker limb of the Experimental Group, resulting in reduced limb strength asymmetry. This improvement is expected to be evident through an increased peak Ground Reaction Force (GRF) measured by the force table during single-leg jumps (Figure 1).

### Intervention

Control Group (CG): Participated in a standard basketball warm-up regimen with exercise applied uniformly across both legs. Experimental Group (EG): Along with the standard warm-up, members performed additional repetitions specifically targeting their weaker limbs during the Strength & Flexibility and Basketball Movements phases. The warm-up regimen was carried out 3 times a week for 25 minutes over 6 weeks, consisting of: 1. General Warm-up, 2. Strength & Flexibility, 3. Basketball Movements, 4. Activation & Readiness.

### Statistical Methodology

In the randomized controlled trial conducted, Linear Mixed Effects Models were used to examine the effects of targeted strength training on limb asymmetry, with a specific focus on CMJ, HorzJump, and LatJump asymmetry. Fixed effects were represented by the time point (pre- and post-



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intervention) and the group (experimental or control), while random effects were represented by the ID of the participants. A two-tailed significance level of $p<0.05$ was established and Bonferroni corrections were applied to control for multiple comparisons during post hoc tests. Cohen's *d* was used for the calculation of effect sizes. All statistical analyses were performed with SPSS. The sample size was determined through a power analysis, which assumed an alpha level of 0.05 and a power of 80% to detect moderate effect sizes. Descriptive statistics for all primary and secondary outcomes were also calculated.

## Results

### Pre- vs. Post-Intervention

Table 1. Comparisons between the Experimental and Control groups

| | Group1 | Group2 | Mean Difference | p-value | Lower | Upper |
|---|---|---|---|---|---|---|
| CMJ Asymmetry | Control_Post-intervention | Control_Pre-intervention | 0.0011 | 0.9 | -0.0381 | 0.0403 |
| | Control_Post-intervention | Experimental_Post-intervention | -0.0516 | 0.0055 | -0.0907 | -0.0124 |
| | Control_Pre-intervention | Experimental_Pre-intervention | -0.0044 | 0.9 | -0.0436 | 0.0347 |
| | Experimental_Post-intervention | Experimental_Pre-intervention | 0.0482 | 0.0104 | 0.009 | 0.0874 |
| HorzJump Asymmetry | Control_Post-intervention | Control_Pre-intervention | 0.0035 | 0.9 | -0.0434 | 0.0505 |
| | Control_Post-intervention | Experimental_Post-intervention | -0.0474 | 0.0474 | -0.0944 | -0.0004 |
| | Control_Pre-intervention | Experimental_Pre-intervention | -0.0056 | 0.9 | -0.0526 | 0.0414 |
| | Experimental_Post-intervention | Experimental_Pre-intervention | 0.0454 | 0.062 | -0.0016 | 0.0923 |
| LatJump Asymmetry | Control_Post-intervention | Control_Pre-intervention | 0.0045 | 0.9 | -0.0438 | 0.0527 |
| | Control_Post-intervention | Experimental_Post-intervention | -0.0286 | 0.3995 | -0.0769 | 0.0196 |
| | Control_Pre-intervention | Experimental_Pre-intervention | 0.0092 | 0.9 | -0.0391 | 0.0575 |
| | Experimental_Post-intervention | Experimental_Pre-intervention | 0.0423 | 0.1046 | -0.006 | 0.0906 |

CMJ Asymmetry: Countermovement Jump Asymmetry. HorzJump Asymmetry: Horizontal Jump Asymmetry. LatJump Asymmetry: Lateral Jump Asymmetry.

The pairwise comparisons focusing on "Pre- vs. Post-Intervention" reveal substantial findings. For Countermovement Jump Asymmetry, a statistically significant mean difference of -0.0527 (p-value = 0.0045) between the Control Pre-intervention and Experimental Post-intervention groups suggests that the intervention led to a notable decrease in Countermovement Jump Asymmetry. Similarly, in the case of Horizontal Jump Asymmetry, the Experimental Post-intervention group also



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showed a statistically significant reduction (mean difference of -0.0509, p-value = 0.029) compared to the Control Pre-intervention group. These findings indicate that the intervention was effective in altering these two measures of asymmetry. However, for Lateral Jump Asymmetry, the mean difference of -0.0331 between the Control Pre-intervention and Experimental Post-intervention groups was not statistically significant (p-value = 0.2733), implying that the intervention did not have a measurable effect on this particular measure of asymmetry. Overall, the results suggest that the intervention had a mixed impact on the measures of asymmetry, being effective for Countermovement Jump Asymmetry and Horizontal Jump Asymmetry but not for Lateral Jump Asymmetry (table 1).

**Experimental Group vs. Control Group**

The pairwise comparisons between the Experimental and Control groups in the post-intervention phase yield important insights. For the Countermovement Jump Asymmetry measure, a statistically significant mean difference of -0.0516 (p-value = 0.0055) was observed, suggesting that the experimental intervention was successful in reducing this measure of asymmetry compared to the control group. Similarly, Horizontal Jump Asymmetry also showed a statistically significant decrease in the Experimental group with a mean difference of -0.0474 (p-value = 0.0474). These results indicate that the intervention had a positive impact on reducing asymmetry in these two measures within the Experimental group when compared to the Control group. However, for Lateral Jump Asymmetry, no statistically significant difference was observed (p-value = 0.3995), indicating that the intervention did not have a significant effect on this measure. Overall, the intervention appears to be effective in the Experimental group for certain measures of asymmetry, specifically Countermovement Jump Asymmetry and Horizontal Jump Asymmetry, but not for Lateral Jump Asymmetry ((table 1)).

**Time and group interaction.**

Subsequently, a meticulous examination of the dichotomies between the experimental and control groups, particularly in the postintervention phase, brought to light a distinctive pattern. The coefficient for the experimental group [T. Experimental] was quantified as -0.090 and achieved statistical significance ($p<0.001$), thereby illuminating a pronounced divergence in the asymmetry of the CMJ between the respective groups, particularly after intervention (0.075 vs. 0.133 respectively). Furthermore, the interaction term, quantified as 0.047, was statistically significant ($p<0.001$), implying a marked distinction in the impact of time points on the asymmetry of the CMJ between the cohorts. Ensuing post hoc tests, adjusted utilizing Bonferroni correction, underscored significant divergences between post-intervention-control and post-intervention-experimental (Adj. $p=0.033$) and between post-intervention-experimental and preintervention control (Adj. $p=0.0268$). Parallel patterns emerged for the HorzJump and LatJump Asymmetry. Both exhibited a significant interaction effect and discernible differences in asymmetry between the experimental and control groups after the intervention, with coefficients of -0.073 ($p = 0.018$) and -0.065 ($p = 0.042$), respectively. However, no significant disparities were identified in post hoc tests following the Bonferroni correction.

Figure 2 shows that the targeted weaker limb strength training did indeed exert a quantifiable influence on the strength asymmetry metrics within the elite female basketball players participating. This is exemplified by discernible variations from pre- to post-intervention within each cohort and salient disparities in the asymmetry between the experimental and control groups after the intervention period.



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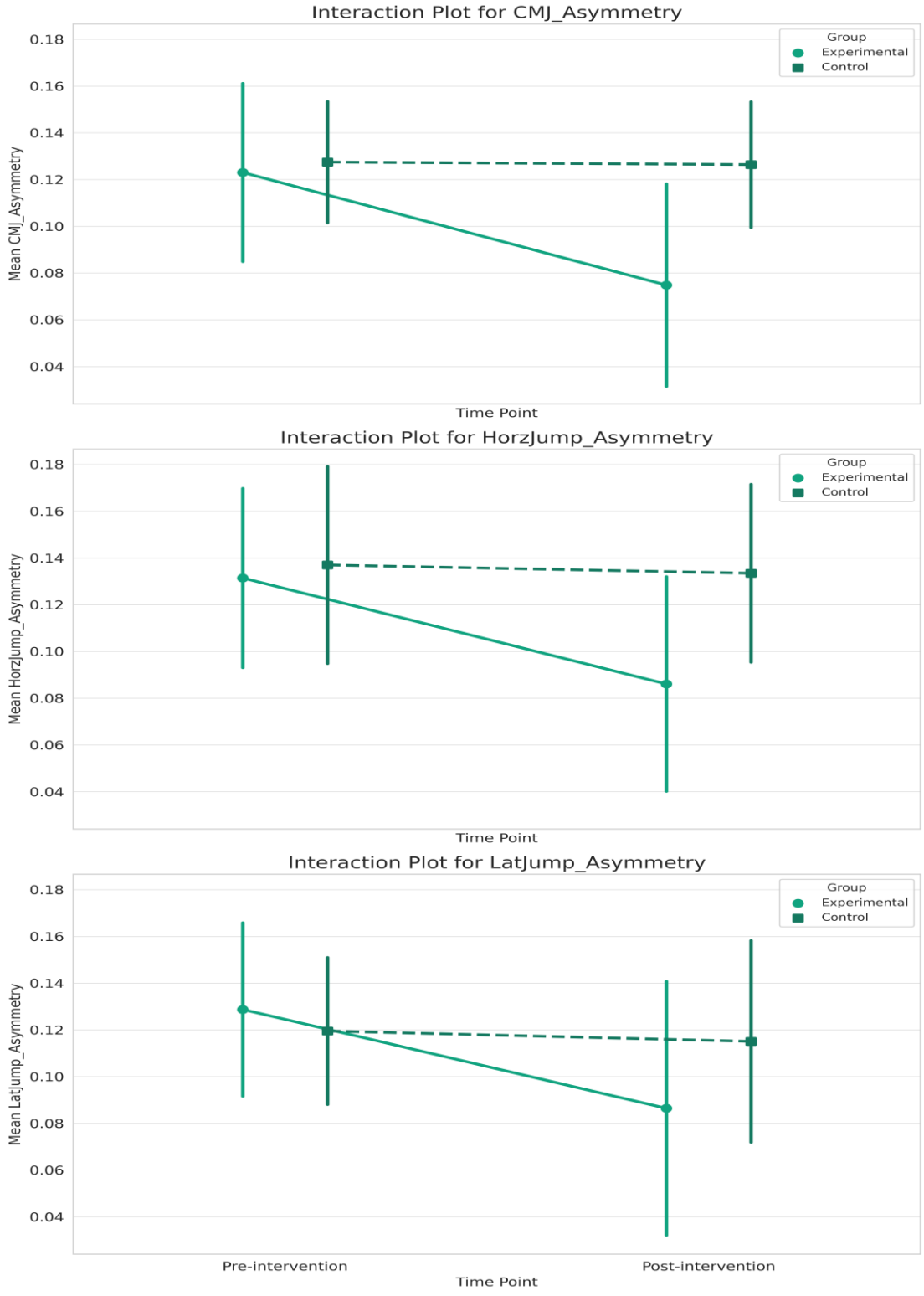


Figure 2. Impact of Targeted Strength Training on Limb Asymmetry



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## Discussion

The research findings indicate that the intervention had a mixed but generally positive impact on measures of jump asymmetry in elite female basketball players. Specifically, the intervention was effective in significantly reducing Countermovement Jump Asymmetry and Horizontal Jump Asymmetry, as demonstrated by both pre- vs. post-intervention comparisons and comparisons between the Experimental and Control groups in the post-intervention phase (p-values ranging from 0.0045 to 0.0474). However, the intervention did not have a statistically significant effect on Lateral Jump Asymmetry in either comparison (p-values of 0.2733 and 0.3995). Further, time and group interaction analyses revealed significant differences in Countermovement Jump Asymmetry between the groups post-intervention and also significant interaction effects for both Horizontal and Lateral Jump Asymmetry, although the latter did not hold up in post hoc tests following Bonferroni correction. Overall, the intervention was particularly effective in altering certain measures of asymmetry but not universally so across all tested parameters.

The intricacies revealed through the exploration of interventions on interlimb asymmetry require a coherent and nuanced synthesis of the findings. Beginning with the most impactful results, the analysis delves into the multifaceted dimensions of interlimb asymmetry, and the implications of the interventions applied.

The research findings in CMJ Asymmetry denote a pivotal aspect of the study, showcasing a significant interaction between the time point and the group. This significant interaction implies a notable differential impact of the intervention between the experimental and control groups, with the group [T. experimental] coefficient revealing a significant difference in CMJ asymmetry between the groups after intervention. This aligns with previous studies suggesting that specific training interventions can induce moderate reductions in asymmetry for single-leg countermovement jumps, emphasizing the potential effectiveness of tailored interventions (Bathe et al., 2023; Bettariga et al., 2022).

The analogous significant interactions observed in HorzJump and LatJump Asymmetry, albeit without significant differences in post hoc tests after correction, reflect the complex and varied nature of interlimb asymmetry and its responsiveness to interventions. These variances in response between different types of asymmetries suggest the necessity for a multifaceted and individualized approach to intervention strategies, considering the distinct muscle groups and biomechanical processes involved in each type of jump.

The implications of the significant interaction terms across all measures are profound, highlighting the critical influence of the timing of interventions on their effectiveness. This underscores the paramount importance of applying interventions at an optimal time point to maximize their impact on reducing asymmetries. It resonates with broader research indicating the contingent effectiveness of interventions on multiple factors including individual variability, the nature of the intervention, and the specific type of asymmetry involved (Gonzalo-Skok et al., 2022).

The absence of significant differences in post hoc tests after Bonferroni correction for HorzJump and LatJump Asymmetry necessitates a deeper exploration into the underlying mechanisms and the refinement of intervention strategies. This could potentially unveil the presence of other confounding variables and optimize the specificity of the interventions applied, contributing to a more robust and refined methodological approach in future research endeavors.

In the realm of athletic training, the outcomes of this research underline the profound implications of such interventions. They not only offer insights into refining training methodologies but also stress the importance of developing balanced and symmetrical strength in athletes, which is crucial for optimizing performance and minimizing the risk of injury (Bathe et al., 2023). The intervention's ability to induce significant reductions in asymmetry postintervention accentuates its potential in optimizing biomechanical efficiency and balance, which are pivotal components in athletic performance optimization.



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## Recommendation

### 1. Recommendations for Practice

The study results strongly suggest that targeted strength training protocols can be effectively integrated into athletic training programs to reduce limb asymmetry. This has the potential to improve athletic performance and minimize the risk of injuries. Coaches, physiotherapists, and athletes are advised to consider implementing these specialized training methods in their regular regimens for optimized outcomes.

### 2. Recommendations for Future Research

For a more comprehensive understanding and broader applicability, future research should consider extending this study longitudinally across various sports disciplines and different age demographics. Additional investigations could also focus on comparing the effectiveness of various interventions aimed at reducing limb asymmetry. Exploring the underlying physiological mechanisms responsible for these asymmetries could provide a more holistic view of the issue and pave the way for more targeted and effective interventions.

## References

Agrawal, V., Gailey, R., Gaunaurd, I., O'Toole, C., & Finnieston, A. (2013). Comparison between microprocessor-controlled ankle/foot and conventional prosthetic feet during stair negotiation in people with unilateral transtibial amputation. *The Journal of Rehabilitation Research and Development*, 50(7), 941-950. https://doi.org/10.1682/ jrrd.2012.05.0093

Bathe, C., Fennen, L., Heering, T., Greif, A., & Dubbeldam, R. (2023). Training interventions to reduce the risk of injury to the lower extremity joints during landing movements in adult athletes: A systematic review and meta-analysis. *BMJ Open Sport & Exercise Medicine*, 9(2), e001508. https://doi.org/10.1136/bmjsem-2022-001508

Bettariga, F., Turner, A., Maloney, S., Maestroni, L., Jarvis, P., & Bishop, C. (2022). The effects of training interventions on interlimb asymmetries: a systematic review with meta-analysis. *Strength and Conditioning*, 44(5), 69-86. https://doi.org/10.1519/ssc.00000000000 00701

Bishop, C., Brashill, C., Abbott, W., Read, P., Lake, J., & Turner, A. (2021). Jumping asymmetries are associated with speed, change of direction speed, and jump performance in elite academy soccer players. *The Journal of Strength and Conditioning Research*, 35(7), 1841-1847. https://doi.org/10.1519/jsc.0000000000003058

Bishop, C., Keijzer, K., Turner, A., & Beato, M. (2023). Measuring interlimb asymmetry for strength and power: a brief review of assessment methods, data analysis, current evidence, and practical recommendations. *The Journal of Strength and Conditioning Research*, 37(3), 745-750. https://doi.org/10.1519/jsc.0000000000004384

Boccia, G., Brustio, P., Buttacchio, G., Calabrese, M., Bruzzone, M., Casale, R., & Rainoldi, A. (2018). Interlimb asymmetries were identified using the rate of torque development in ballistic contraction targeting submaximal torques. *Frontiers in Physiology*, 9. https://doi.org/10. 3389/fphys.2018.01701

Brassart, F., Faupin, A., Hays, A., Bakatchina, S., Alberca, I., Watelain, E., & Weissland, T. (2023). Upper limb cranking asymmetry during a Wingate anaerobic test in wheelchair basketball players. *Scandinavian Journal of Medicine and Science in Sports*, 33(8), 1473-1485. https://doi.org/10.1111/sms.14376

Chen, J., Yi, Z., & Tian, D. (2023). A study on the effect of unilateral strength training intervention on lower limb asymmetry in college basketball players. https://doi.org/ 10.21203/rs.3.rs-2815017/v1

Dos'Santos, T. (2020). Assessing interlimb asymmetries: are we heading in the right direction? *Strength & Conditioning Journal*, 43(3), 91-100. https://doi.org/10.1519/ssc.00000000 00000590

Gonzalo-Skok, O., Sánchez-Sabaté, J., Tous-Fajardo, J., Mendez-Villanueva, A., Bishop, C., & Piedrafita, E. (2022). Effects of Direction-Specific Training Interventions on Physical



Citation
Xie, H., Hongsaenyatham, P., & Rittisom, S. (2024). Reducing Limb Asymmetry in Females Collegiate Basketball: A Randomized Trial. International Journal of Sociologies and Anthropologies Science Reviews, 4 (1), 417-426; DOI: https://doi.org/10.60027/ijsasr.2024.3702

International Journal of Sociologies and Anthropologies Science Reviews
Volume 4 Issue 1: January -February 2024: ISSN 2985-2730
Website: https://so07.tci-thaijo.org/index.php/IJSASR/index
DOI: https://doi.org/10.60027/ijsasr.2024.3702

Performance and Inter-Limb Asymmetries. *International Journal of Environmental Research and Public Health*, 19(3), Article 3. https://doi.org/10.3390/ijerph19031029

Guan, Y., Bredin, S., Taunton, J., Jiang, Q., & Wu, N. (2023). Predicting the risk of injuries through assessments of asymmetric lower limb functional performance: a prospective study of 415 youth taekwondo athletes. *Orthopaedic Journal of Sports Medicine*, 11(8). https://doi.org/10.1177/23259671231185586

Janicijevic, D., Pérez-Castilla, A., Miras-Moreno, S., Ortega-Becerra, M., Morenas-Aguilar, M., Smajla, D., … & García-Ramos, A. (2023). Effect of a high-intensity handball-specific fatigue protocol focused on the leg contralateral to the throwing arm on interlimb asymmetries. *The Journal of Strength and Conditioning Research*, 37(7), 1382-1389. https://doi.org/ 10.1519/jsc.0000000000004422

Nicholson, G., Bennett, T., Thomas, A., Pollitt, L., Hopkinson, M., Crespo, R., & Price, R. (2022). Inter-limb asymmetries and kicking limb preference in English premier league soccer players. *Frontiers in Sports and Active Living*, 4. https://doi.org/10.3389/fspor.2022. 982796

Philipp, N., Crawford, D., Garver, M., Davis, D., & Hair, J. (2020). Interlimb asymmetry thresholds that negatively affect the change of direction performance in collegiate American football players. *SportRχiv.* https://doi.org/10.31236/osf.io/2u6nt

Smajla, D., Knezevic, O., Mirkov, D., & Šarabon, N. (2020). Interlimb asymmetries and ipsilateral associations of plantar flexors and knee extensors rate-of-force development scaling factor. *Symmetry*, 12(9), 1522. https://doi.org/10.3390/sym12091522



Citation
Xie, H., Hongsaenyatham, P., & Rittisom, S. (2024). Reducing Limb Asymmetry in Females Collegiate Basketball: A Randomized Trial. International Journal of Sociologies and Anthropologies Science Reviews, 4 (1), 417-426; DOI: https://doi.org/10.60027/ijsasr.2024.3702