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EVALUATION OF BILATERAL STRENGTH ASYMMETRY AND HAMSTRING–QUADRICEPS BALANCE IN COMPETITIVE UNIVERSITY HANDBALL PLAYERS

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ABSTRACT

The strength of quadriceps and hamstrings muscles play a crucial role in maintaining optimal athletic performance and to prevent injury. Isokinetic testing allows for the isolation of specific muscle groups, such as the knee extensors and flexors, enabling more accurate identification of bilateral deficits relevant to sport-specific actions. Therefore, the purpose of the study was to evaluate bilateral asymmetry of knee extensor strength, knee flexor strength, and H:Q ratio of female handball players. To accomplish the purpose twenty-three (23) female handball players were selected as subjects from Annamalai University. The peak torque of knee extensor and knee flexor was obtained for 60°/s and 180°/s in both dominant and non-dominant leg and H:Q ratio was calculated. To assess the bilateral difference paired *t* test was applied. The paired *t* test demonstrated significant inter-limb differences in knee flexor peak torque and the H:Q ratio at 60°/s ($p < 0.05$). However, all remaining comparisons failed to reach statistical significance. Therefore, the findings of this study show that the dominant leg possesses significantly greater hamstring strength and a stronger hamstring-to-quadriceps balance compared to the non-dominant leg. These results provide clear evidence of bilateral strength asymmetry in the knee flexors among female handball players.

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INTRODUCTION

Handball is a high-intensity, intermittent team sport that demands rapid transitions between offensive and defensive actions. Players frequently perform explosive movements such as sprinting, sudden acceleration and deceleration, jumping, cutting, pivoting, and powerful throwing. These actions place considerable biomechanical and neuromuscular demands on the lower limbs, particularly the knee joint musculature. Among the lower-limb muscle groups, the knee extensors (quadriceps) and knee flexors (hamstrings) play a crucial role in maintaining optimal athletic performance. The quadriceps are responsible for producing force during jumping, sprinting, decelerating, and stabilizing the knee during directional changes. The hamstrings counterbalance this action by providing dynamic knee stability, assisting in hip extension for acceleration and jumping, and preventing excessive anterior tibial translation—essential for ACL protection (González-Ravéet *al.* 2014; Risberget *al.* 2108; Diker, Struzik, Ön, Zileli 2022). In handball, the importance of strength in these muscle groups becomes even more pronounced because players repeatedly execute explosive vertical jumps for

shooting and blocking, intense defensive shuffles, rapid changes of direction, and forceful landings after jumps (Fristrupet *al.* 2024). Adequate extensor–flexor strength enables efficient force production, enhances movement economy, and supports technical skills such as throwing power, fast breaks, and defensive tackles. Furthermore, the hamstring-to-quadriceps (H/Q) strength ratio is a key indicator of muscular balance around the knee. Maintaining an optimal ratio not only improves explosive performance but also reduces the risk of common handball-related injuries such as ACL tears, patellofemoral pain, and hamstring strains. Since handball involves frequent single-leg actions—pivoting, take-off steps, and unilateral landings—muscular balance and bilateral symmetry in knee strength are essential for both performance and long-term athlete health (Gonosovaet *al.* 2018, Marika *et al.* 2024). Therefore, the purpose of the study was to evaluate bilateral strength asymmetry of knee extensor strength, knee flexor strength, and H:Q ratio of female handball players. This provides crucial insight into the physical preparedness of handball players. Strength assessments can guide training interventions, optimize performance in match-specific movements, and help prevent lower-limb injuries.

Understanding the role of these muscle groups is fundamental for coaches, sport scientists, and clinicians aiming to improve handball performance and athlete well-being.

MATERIALS AND METHODS

Subjects: Twenty-three (23) female handball players were selected as subjects. The selected subjects represented Annamalai University in South Zone Inter University handball Competition for the year 2022-23. The selected subjects gave their willingness to participate in this study. A written consent was obtained prior to initial data collection. They were also informed that they were free to opt out of the study at any time if they felt any discomfort but no dropouts were there.

Variables: Knee extensor and flexor muscle strength was measured using Isokinetic Machine (Tur, Germany). The peak torque of knee extensor and knee flexor was obtained in 60°/s and 180°/s in both dominant and non-dominant leg. H:Q ratio is measured using formula (Dominant Leg flexion / Dominant Leg extension)×100. The data was collected from MYAS-AU Department of Sports Sciences, Exercise Physiology Lab, Chidambaram, Tamilnadu, India.

Statistical Technique: The data collected from women handball players were tested using paired *t* test to ascertain the bilateral difference in isokinetic measures. All the statistical tests were calculated using the statistical package for the social science (SPSS) for windows (Version 16). The level of statistical significance was set at $p < 0.05$.

RESULTS

The paired *t* test showed significant difference in peak torque for flexors at 60°/s angular velocity between the dominant leg and non-dominant leg ($t = 2.438$, $p = 0.023$), but 60°/s and 180°/s of angular velocity of knee extensors and flexors peak torque failed to show significant difference ($p > 0.05$). However, H/Q ratio at 60°/s showed significant difference ($t = 2.110$, $p = 0.047$) but at 180°/s failed to show significant difference.

et al., 2017), and among male athletes in general (Jones & Bampouras, 2010), as well as in both volleyball and soccer players (Magalhães *et al.*, 2004). The present study found that female university handball players exhibited a 9.71% difference in hamstring strength between their dominant and non-dominant legs. Comparable bilateral strength disparities have been documented in other sports populations. For instance, Hadžić *et al.* (2013) noted such asymmetry—mainly affecting the quadriceps—in senior basketball athletes, while Menzel *et al.* (2013) reported an average imbalance of 9.14% in professional male soccer players. Differences in hamstring strength between the dominant and non-dominant legs are likely influenced by sport-specific unilateral demands, such as repeated jump-shot actions in handball. These movements can reinforce one-sided loading patterns, and general bilateral strength training may not fully correct such imbalances, especially when training drills consistently prioritize the dominant leg (Bishop *et al.*, 2021).

Additionally, dominant limbs often demonstrate superior neuromuscular control and greater muscle activation compared to the non-dominant side (Sadeghi *et al.*, 2000). Together, these factors can lead to reduced force-production capacity in the weaker limb, which may adversely affect athletic performance (Lockie *et al.*, 2012; Negrete *et al.*, 2007). The current study identified an imbalance between hamstring and quadriceps strength, with H/Q ratios at 60°/s ranging from 74.06 to 66.42, values that fall within the expected normative range. Previous research indicates that healthy individuals typically exhibit H/Q ratios between 50% and 80% (Bennell *et al.*, 1998; Cheung *et al.*, 2012; Kabacinski *et al.*, 2018), confirming that both limbs in our sample fall within these limits. The athletes showed a lower H/Q ratio in the non-dominant leg, likely due to comparatively stronger quadriceps muscles on that side. Since effective execution of handball-specific movements—such as jump-shot feints, sprinting, and cutting—relies heavily on quadriceps strength, the dominant leg may develop differently. Additionally, our results revealed that the H/Q ratio decreased in the dominant leg and increased in the non-dominant leg as the testing speed rose from 60°/s to 180°/s.

Table 1. Bilateral Asymmetry of knee Strength of female handball players

Variables	Angular Velocities	Dominant Leg	Non-Dominant Leg	<i>t</i> value	<i>p</i> value
Peak Knee Extensor Torque [N.m]	60°/s	107.73 ± 27.65	104.74 ± 28.94	0.997	0.330
	180°/s	91.46 ± 20.17	90.68 ± 23.89	0.263	0.795
Peak Knee Flexor Torque [N.m]	60°/s	76.71 ± 21.12	69.26 ± 19.98	2.438*	0.023
	180°/s	62.30 ± 16.64	61.36 ± 19.98	0.478	0.637
H/Q Ratio [%]	60°/s	74.06 ± 11.72	66.42 ± 21.19	2.110*	0.047
	180°/s	68.11 ± 9.00	67.66 ± 11.67	0.476	0.638

*Significant at 0.05.

DISCUSSION

High-level handball performance relies on players possessing strong physical capacities such as speed, power, strength, coordination, and sufficient joint mobility. In the present study, larger bilateral differences were identified in hamstring peak torque and hamstring quadriceps ratio at 60°/s. The findings of the present study align with earlier research showing that the dominant leg typically produces greater hamstring peak torque than the non-dominant leg. Comparable strength patterns have been reported across various sports, including soccer (Kellis *et al.*, 2001; Tourny-Chollet *et al.*, 2000), softball (Newton *et al.*, 2006), basketball (Thomas *et*

This study is subject to certain limitations, most notably the small number of participants and the timing of data collection, which took place before the competitive season in order to establish baseline strength values for the female handball players. The results demonstrated clear bilateral strength discrepancies and imbalances in the H/Q ratio, suggesting that current handball-specific training programs may not sufficiently develop hamstring strength. These weaknesses could elevate the likelihood of hamstring injuries and potentially affect overall team performance. Consequently, implementing focused training strategies—particularly those aimed at enhancing knee flexor strength in the non-dominant leg—appears essential.

CONCLUSION

The findings of this study indicate that, at 60°/s, the dominant leg exhibits greater hamstring strength and a higher hamstring-to-quadriceps ratio compared to the non-dominant leg, confirming the existence of bilateral strength asymmetry in the knee flexors. Such imbalances may affect key performance actions, including jumping, sprinting, and directional changes, and may also carry implications for injury susceptibility and training design. Therefore, strength and conditioning professionals should consider modifying or incorporating both bilateral and unilateral training strategies to enhance hamstring strength and address H/Q ratio discrepancies, as doing so is essential for maintaining knee stability and reducing the risk of ACL injuries.

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