

## **Impact of Lower Limb Strength Asymmetry on Performance and Injury Prevention in Pakistani Soccer Players**

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### **Abstract**

This research was aimed at investigating how lower limb strength asymmetry affects soccer players, especially in their overall performance and the likelihood of injury. In soccer, soccer players are more likely to have stronger legs, and the leg that dominates is the one that is mostly used in technical activities like passing, dribbling, shooting, and kicking. Due to this fact, the dominant leg can be very strong compared to the non-dominant leg. This is instinctive, as the movements that are necessary in sport are repetitive. Nevertheless, in the case of a high level of strength disparity between two legs, it may cause a set of adverse outcomes for players. The strength disproportion between the non-dominant and dominant legs may be a hindrance to the performance of a player, whereby he/she may not perform the skills effectively. Such asymmetry may also interfere with neuromuscular efficiency, which results in reduced coordination and motor control during play. Besides this, the strength asymmetry of the lower limbs has been attributed to a higher risk of injury, especially non-contact injury such as strains and ligament tears. These injuries are also because the non-dominant leg is weaker and cannot withstand the pressure that it has been subjected to during high intensity things like sprints, sudden change of direction, or deceleration. In this case, the dominant and non-dominant leg strength of Pakistani elite male and female soccer players was measured. The findings showed that there is a high degree of asymmetry between the strength of the lower limbs of the players, where the dominant leg always performed better than the non-dominant one. Values of asymmetry above the 10-15 percent level were associated with performance losses as well as increased risk of injury. The paper ends with the recommendation that lower limb strength imbalance should be corrected by using specific training programs to minimize the risk of injuries and increase the performance of soccer players.

**Keywords:** Lower Limb Strength; Soccer; Injury Prevention; Asymmetry; Performance.

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## **Introduction**

In professional soccer, repeated use of the preferred (dominant) leg for technical actions such as shooting, passing, or dribbling may cause adaptations that increase asymmetry between limbs (Krondorf, 2018). Although some asymmetry is considered functionally normal, excessive strength differences can negatively affect biomechanical efficiency and movement control. Consequently, assessing and comparing dominant and non-dominant leg strength provides critical insight into an athlete's neuromuscular balance and overall performance readiness (Jo et al., 2025).

Pakistan's national soccer players, who participate in regional and international competitions, represent an under-researched population in sports science literature (Nadeem & Ahmed, 2025). Despite growing global emphasis on evidence-based conditioning, there is limited research quantifying bilateral leg strength among Pakistani soccer athletes using standardized testing such as isokinetic dynamometry and one repetition maximum (RM) assessments. The lack of empirical data constrains the development of targeted strength and injury-prevention programs (McClure et al., 2010).

With this research, the soccer coaches of universities and colleges all over Pakistan will know about the strength of the

lower limbs of National Soccer Players of Pakistan Soccer Team, and they will know at what level they need to prepare their players' strength in the dominant leg and non-dominant leg (Krondorf, 2018). They will also be able to bring the strength of the non-dominant leg to par with the dominant leg strength. This will, in the future, give rise to more fit players at the District, Division, and Provincial levels.

In sports science, the concept of lower limb symmetry, that is, the relative equality in strength, power, or function between the dominant and non-dominant legs, has gained increased attention. Imbalances between limbs may impair performance and elevate injury risks (Helme et al., 2021). Lower limb strength plays a decisive role in skills such as sprinting, jumping, tackling, and kicking, all of which depend on neuro-muscular balanced function between dominant and non-dominant legs (Aquilino, 2024).

Disparities and irregularities in strength among lower extremities can affect not only athletic performance but also increase the risk of injuries and muscular strain. This study helps significantly in filling the gap by methodically probing dominant and non-dominant leg strength among Pakistan's national soccer players using unconventional measurable methods. The results from this study will have a

positive impact on the Pakistan football community (Krondorf, 2018). Evaluating and understanding real-time training camps of strength can have a very good effect on an athlete's muscles of the dominant and non-dominant legs. In National soccer, even very little improvement in speed, jumping, heading, and shooting can play a vital role in changing the results of a competitive soccer match. This study focuses on investigating the strength asymmetry between dominant and non-dominant legs in elite Pakistani soccer players. It aims to understand the impact of these imbalances on performance outcomes, including sprinting, agility, and jumping abilities, and how asymmetry correlates with injury risk.

### ***Concept of Limb Symmetry in Sports***

Dominant and non-dominant symmetry states that both the lower limbs have the same muscular strength, neuromuscular activation, and biomechanical yield. In sports science, symmetry is considered a marker of balanced musculoskeletal function and efficient kinetic-chain movement. Soccer is such a sport where the dominant leg assumes a dominant role and develops asymmetry due to repeated training in tasks such as shooting, dribbling, and jumping (Aquilino, 2024).

Symmetry is essential not only for athletic performance but also for

maintaining optimal joint health and minimizing the risk of chronic overuse injuries. Excessive asymmetry, typically above 10–15%, has been associated with compensatory movement patterns, reduced neuromuscular efficiency, and increased risk of soft-tissue injuries. Thus, examining limb symmetry is a core aspect of athlete profiling, rehabilitation monitoring, and performance optimization in football (Haddad, 2024).

### ***Mobility and Functional Movement***

Functional movement and mobility are some of the key elements of overall physical health and athletic performance. Mobility refers to the ability of a joint to actively move in its complete range of motion, whereas functional movement refers to organized and effective patterns of movement that simulate activities of daily living and sports. A combination of these factors is the basis of pain-free, efficient and safe movement both in everyday activities and in sports (Moulton et al., 2019).

Adequate mobility will guarantee the smooth coordination of joints and muscles without any limitation. To monitor, in this example, a lack of hip or ankle mobility may adversely affect the squat performance, causing compensatory mechanisms that increase the risk of injury (Ali et al., 2022). When mobility is improved by specific stretching, myofascial

release, and dynamic warm-ups, people will be able to maintain high posture, increase muscle activity, and reduce stress on joints. This argument is especially relevant in sporting scenarios where repetitive tasks and heavy loads are dominant (Prentice, 2024).

### ***Dominant and Non-Dominant Leg Function in Football***

In soccer, the basic difference between the lower limbs is an essential distinctive nature of practical performance, neuromuscular control, and transfer competence. Soccer is a game in which most of the actions are asymmetry and most actions are performed like kicking, passing, dribbling, tackling with one leg, and that leg is called the dominant leg (D-Leg). whereas the non-kicking foot, which is called the dominant leg (ND-Leg), has its main focus or action to provide balance to the dominant leg. With the passage of time, the above-mentioned unilateral movements of the lower limbs bring practical, structural, and neuro-muscular imbalances in both limbs under discussion (Stafford, 1937).

The growth of limb supremacy is partially due to early age training, specific positional play, and biomechanical specialization. The soccer players who have been training for longer periods, like national or international players, show specific asymmetry in lower limbs due to certain repeated training related to their

game (Guilherme et al., 2015). Because of asymmetry in soccer players there are reasons to believe that the practical results of players improve, but there are more chances of injury. However, when better conditioning training camps and training manuals are developed, the asymmetrical decreases with the passage of time (Fousekis et al., 2010).

### ***Physiological Basis of Muscular Imbalance***

Lower limb asymmetry rises because of composite connections among neuromuscular variations, repeated use of similar actions, biomechanical loading, and structural muscle changes. Physically, repeated unilateral movements strengthen specific muscle groups disproportionately compared to their other limb. For example, repeated shooting at the goal by the dominant leg in soccer gives way to hypertrophy in the kicking foot, and there is increased activation of quads and hip flexors in the dominant leg, whereas the non-kicking foot, that is the non-dominant leg, adjusts only for backing and balancing (Bond et al., 2017; Fousekis et al., 2010).

The coordination of the brain and muscles repeatedly in soccer players gives progress to motor patterns that increase the performance of the dominant leg, it results in better motor-unit performance, faster firing rates of neurons, and enhanced management

of lower limbs. With the passage of time, this difference in muscle strength gives purposeful inequality in muscle strength and performance in dominant and non-dominant limbs (Błażkiewicz et al., 2025).

### ***Limb Asymmetry and Injury Risk***

The repeated use of the dominant leg in COD, high-speed turns, or even a slight difference in asymmetry can have a major impact on neuromuscular control and joint control. If the players don't address these issues in a timely manner, they are more likely to have injuries, chronic injuries, and medical issues (Bigoni et al., 2017). Regarding national-level soccer, where teams and players remain in training for 6-9 months and face stiff competition weekly, these risks increase tenfold, and dominant leg and non-dominant leg factors are massively important. (Haddad, 2024).

### ***Asymmetry as a Predictor of Injury***

Clinically, it has been proven that asymmetry has been repeatedly classified as the main indicator of injury risk. Soccer players who have a < 10-15% difference in strength in their lower limbs are more likely to have a larger number of injuries in their career than those players who have symmetry in their lower limbs, such as in the hip, knee, or ankles (Haddad et al., 2023). This is because the human body does not have enough ability to distribute strength evenly across a wide range of muscles

equally during physical actions. As the dominant leg is stronger and the non-dominant leg is weaker (Razmilić, 2024).

The objective of the study was to assess the impact of lower limb strength asymmetry on soccer performance and injury risk among elite male and female soccer players in Pakistan. The hypothesis was that there is a statistically significant difference in lower limb strength between the dominant and non-dominant legs of elite male and female soccer players in Pakistan.

### **Material and Methods**

The research took the form of a cross-sectional comparative study and was used to measure the asymmetry of lower limb strength between dominant and non-dominant legs among elite Pakistani soccer players and the consequences of this on performance and injury risk. Eighty athletes, including 40 males and 40 females aged 18-38 years, were recruited out of national and professional-level training camps. The participants had not less than five years of organized competitive playing experience and were undertaking regular strength and conditioning programs. Sportspeople were not allowed when they had a lower limb injury within six performances, had undergone lower extremity surgery, or had some neurological or musculoskeletal disorder that could influence performance results. Informed consent was also taken in

writing before the data were collected, and all procedures were carried out in harmony with the accepted ethical standards in research on human performance. A combination of self-reported preferred kicking leg and objective functional verification using a single-leg hopping task and ball striking task established lower limb dominance. The leg that was always employed in kicking and which showed high coordination levels in performing the tasks was regarded as the dominant leg. The measurements were done in an indoor performance facility, which controlled the environment to allow consistency in testing. The participants were administered a pre-test training program, which involved five minutes of low-intensity jogging, dynamic mobility exercises of the hip, knee, and ankle joints, and submaximal familiarization trials in each strength test. Maximal efforts were separated by adequate two to three minutes of rest to reduce the interference of fatigue. Two resistance-based tests were used to measure the unilateral lower limb strength, including the single-leg squat and the unilateral incremental leg press test. In the case of the single-leg squat test, the athletes were put under supervision to perform controlled repetitions to guarantee the standardization of depth, knee position, and trunk stability. The external load was gradually brought up to the point of

## **Results**

maximum voluntary force production using the correct technique. In the unilateral leg press test, the weight was gradually increased until the test subject was unable to perform a full cycle of the prescribed range of motion. The maximum weight that each limb could lift successfully was measured in kilograms and taken to the analysis. To increase reliability, both tests were repeated, and the best valid trial was selected. The magnitude of imbalance was determined through the calculation of inter-limb strength asymmetry by using a standard percentage difference formula regarding the stronger limb. The descriptive statistics, such as mean, standard deviation, median, range, skewness, and kurtosis, were calculated in male and female groups. The Kolmogorov-Smirnov test was used to test the data normality. Non-parametric analysis was used since the distribution was not normal. The Wilcoxon signed-rank test was employed to compare the strength of dominant and non-dominant limbs among the subjects, with the level of statistical significance at  $p < 0.05$ . This methodological approach provided an opportunity with a strong quantification of bilateral strength asymmetry and a solid foundation on which to study the applicability of this knowledge area in performance optimization and injury prevention among elite Pakistani soccer players.

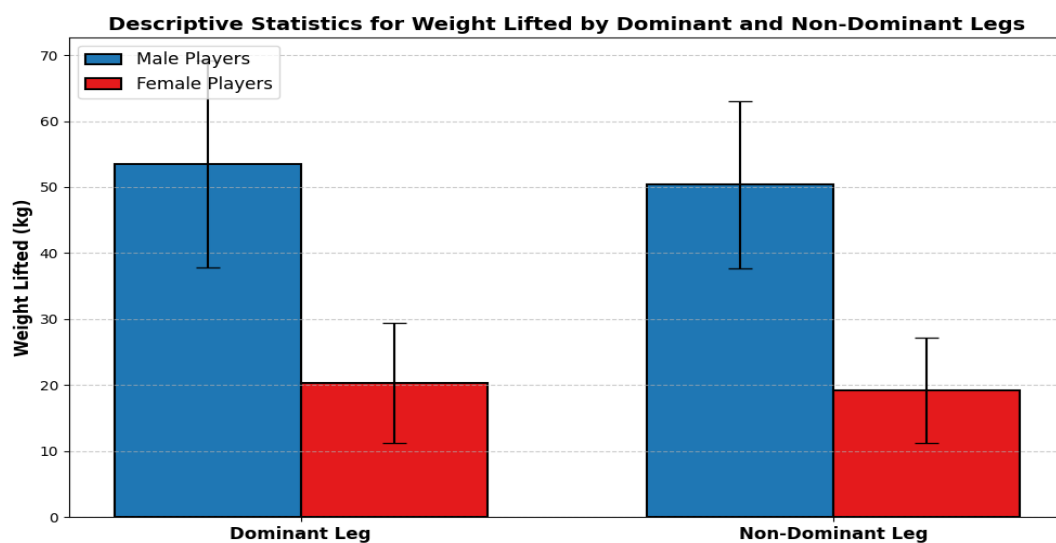
**Table 1.** Descriptive Statistics for Weight Lifted by Dominant and Non-Dominant Leg

Variable	Male Players (M ± SD)	Female Players (M ± SD)
Dominant Leg (kg)	53.46 ± 15.7	20.37 ± 9.09
Non-Dominant Leg (kg)	50.37 ± 12.7	19.22 ± 7.93
Median (kg)	52.0 ± 17.5	15.00 ± 10.0
Minimum (kg)	42.0	14.00
Maximum (kg)	102.0	50.0
Range (kg)	60.0	35.0
Skewness	1.99	2.12
Kurtosis	3.697	4.37

*Note.* The table provides the descriptive statistics of the weight lifted by the dominant and non-dominant leg of 80 soccer players classified as male and female.

The average weight lifted by male players was 53.46 kg (+- 15.7) with the dominant leg and 50.37 kg (+- 12.7) with the non-dominant leg, with a median of 52.0 kg. Male players lifted weights between 42.0 kg and 102.0 kg, giving a range of 60.0 kg. In female players, the mean weight lifted was 20.37 kg (+- 9.09) with the dominant leg and 19.22 kg (+- 7.93) with the non-dominant leg. Female weight was 15.0 kg, and the range of weight was 35.0 kg, with a minimum of 14.0 kg and a maximum of 50.0 kg. The male and female data demonstrate positive skewness, with skewness values of 1.99 among males and 2.12 among females, indicating that more players in both categories lifted lighter weights. Kurtosis values of 3.697 and 4.37, respectively, for males and females, indicate that the female data is more concentrated around the mean and has more extreme values than the male data, which is less concentrated around the mean. In general, the data show significant variation in strength among both groups, with males having higher average strength but more spread values.

**Figure1.** Descriptive Statistics for Weight Lifted by Dominant and Non-Dominant Legs



The bar chart presents the weight lifted by the dominant and non-dominant legs when the subjects were in a sitting position in male and female soccer players. Male players were lifting much heavier weights than the female players with dominant leg weights of about 50 kg and the non-dominant leg about 45 kg. Conversely, the average weight lifted by female players was about 20 kg and 19 kg, respectively, and the error bars were significantly smaller, which depicts a smaller variation. The graph indicates that there is a distinct difference in the strength of the two groups, with males showing a very high lifting capacity of both legs. The broader error bars in the male players are an indication of more variation in the strength of male players.

### **Discussion**

This study supports the results of other studies that indicate that differences in lower limb strength above 10-15 percent result in poor performance and increased risk of injury, especially non-contact ones (Haddad, 2024). The findings of the study revealed that the dominant leg in both genders of soccer players was always better than the non-dominant leg, and the difference in the strength of the dominant leg was more pronounced in the male players. These results support the notion of the literature review that too much

asymmetry has an impact on neuromuscular control and joint stability, making the body vulnerable to injury (Prentice, 2024). The results of the study can be used to formulate injury-preventive measures especially to soccer players in Pakistan by addressing these imbalances using specific training interventions as emphasized in the literature (McClure et al., 2010). The current research contributes to the empirical information available, and it highlights the necessity of corrective training in order to improve performance and minimize the risk of injuries among soccer players.

### **Conclusion**

The results of this paper highlight the necessity of keeping the lower limb strength balanced to achieve maximum athletic performance and prevent injuries. The high disparities in strength found in both male and female players indicate the possible dangers of such disparities, especially in high-intensity games such as soccer. The findings agree with the earlier studies that show that asymmetry of more than 10-15% between the legs is harmful to performance and can cause injury. The research highlights the necessity of corrective training interventions to alleviate asymmetry and enhance the overall performance, and lower the chances of injury among soccer players. The study is

essential in informing soccer athletes in Pakistan about training practices and injury prevention programs. This paper discusses the effect of lower limb strength inequality on soccer players in terms of performance and risk of injury. The study included high-level male and female Pakistani soccer players and it studied their dominant and non-dominant leg strength. The findings indicated that there was a high level of asymmetry with the dominant leg performing better compared to the non-dominant leg. The asymmetry was associated with performance losses and higher risk of injury particularly non-contact injuries. The paper recommends the use of specific training interventions to address these imbalances and improve performance as well as reduce the risk of injury. This study is a contribution to the existing literature in the field of sports science since it bridges the gap in the literature on the lower limb strength asymmetry among Pakistani soccer players.

### **Limitations of the Study**

It should be noted that there are a number of limitations. First, the cross-sectional study design does not allow causal inferences between strength asymmetry, performance deficits, and risk of injury. Although associations can be determined, longitudinal follow-up would be necessary to determine whether asymmetry is a direct

predictor of injury incidence or performance loss. Second, strength was measured using unilateral squat and leg presses instead of isokinetic dynamometry that is considered a gold-standard technique of measuring torque production at controlled velocities. Despite the roominess and environmental validity of the chosen tests, they might not be able to isolate particular muscle groups so precisely. Third, the injury risk was deduced based on the literature asymmetry thresholds, as opposed to following the development of injury in the sample. This limits the possibility of developing direct predictive validity. Fourth, playing position, training load, and seasonal phase were not controlled in the study and all these factors could be affecting the limb dominance adaptations and strength variability. Lastly, neuromuscular variables were not measured (rate of force development, electromyographic activity, and movement biomechanics) to gain a deeper understanding of the underlying mechanisms of asymmetry.

### **Recommendations**

According to the results, the systematic implementation of structured unilateral strength training in conditioning programs of elite soccer players should be performed. Corrective measures aimed at the weaker limb using single-limb

resistance exercises, neuromuscular control exercises and eccentric strengthening can be used to decrease asymmetry above the 10-15% range. Bilateral strength screening should be introduced on a regular basis, both at preseason and midseason, to track the trends of asymmetry. To reach the objective of balanced development, coaches and strength professionals should personalize the progression of loads instead of predominantly focusing on the repetition of the dominant leg skills. Also, objective asymmetry benchmarks are to be included in rehabilitation programs prior to clearance to resume play to minimize the risk of reinjury.

### **Future Directions**

The future studies must consider longitudinal designs in order to establish the direct relationship between inter-limb asymmetry and injury occurrence during competitive seasons. The future cohort research involving the non-contact injury and the measure of strength would present more causal evidence. This would be complemented by the introduction of isokinetic dynamometry, force plates and electro-myography to further analyse the torque production, neuromuscular activation patterns and rate of force development imbalances. Position based analysis can expose the presence of different asymmetry patterns in defenders,

midfielders, and forwards. The intervention-based studies would also be justified to check the efficiency of the unilateral corrective training programs to reduce the asymmetry and enhance the sprint, agility, and jump performances. Including youth and developmental players in the sample may help to answer the question of when asymmetry is first observed and whether early remedial measures are advantageous.

### **Implications of the Study**

The paper presents one of the earliest empirical studies that measures the lower limb strength asymmetry among elite Pakistani soccer players. The results support the clinical significance of bilateral strength balance monitoring in high-performance settings. To coaches and sports scientists, the findings suggest the need to incorporate asymmetry screening in the normal performance testing systems. In terms of injury prevention, non-contact injuries can be prevented by identifying athletes who have more than 10-15 percent of asymmetry and intervening before the onset of injuries. On a national scale, the research is useful in the formulation of evidence-based conditioning recommendations that are specific to Pakistani soccer players. Finally, lower limb asymmetry can be considered as an effective intervention to improve the

neuromuscular efficiency, performance outputs, and potential reduction of the injury burden in elite football populations.

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