Can Muscle Imbalances Increase The Risk of Injury?

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Muscle imbalances refer to asymmetries in muscle size and strength, either between the left and right sides of the body (bilateral) or between opposing muscle groups (agonist-antagonist). It has been suggested that such imbalances, particularly in the knee, may contribute to an increased risk of injuries such as ACL tears. Similarly, imbalances in the shoulder could be a potential risk factor for injuries commonly seen in overhead and throwing athletes. Effectively, the knee and shoulder are among the most extensively studied joints in injury-related research. This text presents some of the latest findings about muscle imbalances as risk factors in sports injuries.

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Studying injury risk factors is a complex process. It typically involves screening athletes for specific characteristics and tracking a cohort over time to record injury incidence. These risk factors can be internal (related to individual traits) or external (influenced by the environment). A more rigorous approach is a controlled trial, where randomized groups of athletes undergo targeted injury prevention programs designed to modify a particular risk factor. However, such studies can be challenging to design accurately. Therefore, practical experience, biomechanical knowledge, and individual variability should be considered when developing injury prevention strategies.

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Helme et al. (2021), in their systematic review of 28 cohort studies, concluded that there is insufficient evidence to determine whether lower limb asymmetries contribute to injury risk. Many of these studies employed functional movement screening, while others used dynamic tests such as unilateral hops, leg presses, or isolated isokinetic (constant velocity) assessments. These studies examined both intra- and inter-limb imbalances; however, a key limitation was the lack of normalization for training hours, which represents a significant source of inaccuracy in assessing injury risk. Furthermore, it seems that hamstrings-to-quadriceps torque ratio (H:Q-ratio; measured with isokinetics) at any velocity can’t be used to predict ACL and hamstring injuries (Kellis et al. 2023).

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The rationale behind the H:Q ratio as a risk factor is at least partly based on the idea that an increased knee extension moment could push the hamstrings beyond their eccentric force production capacity, particularly during fast movements. However, the absolute strength of the hamstrings may be more critical than the ratio itself. For example, during running, eccentric hamstring tension reaches extreme levels, and if this tension exceeds the muscle's capacity, injuries can occur. This is supported by evidence showing that eccentric hamstring exercises, such as the Nordic hamstring curl, are effective in preventing hamstring injuries in many running sports.

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Kwan et al. (2021) reported that similarly to the knee, muscle weakness in the external and internal rotation and also their ratio might have some predictive power in shoulder injuries in overhead athletes. However, this evidence was demed pretty weak. But the aforementioned idea might apply here as well; during power throwing the rotators of the shoulder joint might experience high levels of eccentric tension which might cause weaker muscles to damage.

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Potential injury risks related to inter-limb differences may stem from more complex motor control mechanisms. Significant limb deficiencies often occur, for example, after invasive surgeries, such as ACL reconstruction. While the operated leg often undergoes extensive rehabilitation, some deficits may persist. In dynamic team sports, for example, an athlete may unconsciously initiate a change of direction using the weaker limb, expecting it to produce force at the same level as the healthy leg. This mismatch could result in an acute load exceeding the tissue’s capacity, leading to injury. Additionally, such asymmetries may cause compensatory movements when the weaker limb cannot fully execute the intended motion. For instance, a weak hamstring and insufficient knee flexion during running may lead to compensation through increased hip flexion. These altered movement patterns can create potentially injury-prone situations, particularly if the athlete is unaware of them.

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Sports injuries occur in various situations, but they ultimately result from an acute or chronic load that exceeds the tissue’s capacity to withstand stress. Therefore, the most effective prevention strategy revolves around proper load management and recovery throughout the training cycle. While many acute injuries, particularly in contact sports, are unpredictable, fatigue plays a significant role in predisposing athletes to these situations. Muscle imbalances may contribute to injury risk in certain cases, but their overall impact is likely minimal in the broader context. Ultimately, a well-rounded and progressively structured training program is key to preparing the body for the demands of high-performance sports.

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