SPRINTING STRIDE BREAKDOWN AND HAMSTRING INJURIES

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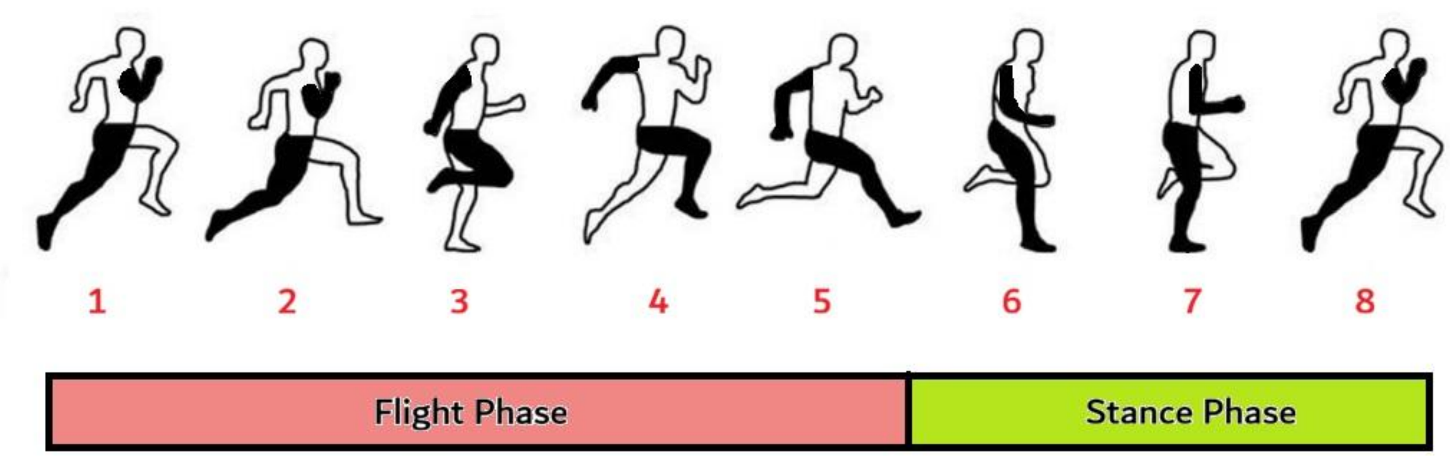
The sprinting stride is composed of two primary phases: the stance phase, when the foot is on the ground, and the flight phase, when both feet are in the air. These phases are further categorized into specific sub-phases to optimize ground force and energy transition efficiency.



1. Stance Phase (Ground Support). (right leg sequence 6 → 8 above)

The stance phase is dedicated to the generation of horizontal and vertical force to move the sprinter forward, and consists of:

- **Initial Contact:** The forefoot makes active contact with the ground, landing slightly ahead of the body's center of mass. (6)
- **Mid-support:** As the body passes directly over the supporting foot, the sprinter must maintain rigid ankle and knee joints to absorb force and prevent energy loss. (7)
- **Propulsion/Push-off:** The final part of the stance phase that involves the forceful extension of the hip, knee, and ankle joints to propel the body forward, ending when the toes leave the ground. (8)

2. Flight Phase (In the Air)

The flight phase focuses on transitioning the legs efficiently to prepare for the next stride, and consists of:

- **Early Flight/Recovery:** Once the trailing leg leaves the ground, the heel quickly folds up toward the glutes. This shortens the lever of the leg, which allows it to swing forward more rapidly. (1 → 3)
- **Late Flight/Preparation:** The thigh swings forward and upward while the opposite leg begins to drive down toward the ground in preparation for the next foot strike. (4 → 5)

Key Factors in Maximum Sprinting Speed.

To achieve and maintain maximum sprinting speed, it involves a complex coordination of specific muscle groups acting through different phases of the running gait. The following elements are critical:

1. Powerful Hip Extension and Drive

- **Gluteus Maximus:** This is a primary driver of forward motion. It generates large hip extension moments during the early stance phase to propel the body forward. (7 → 8)
- **Hamstrings:** During the stance phase, the hamstrings contribute to hip extension. They may function near-isometrically while producing the high forces necessary to transition rapidly from ground contact to propulsion. (7)

2. Efficient Deceleration and Limb Control (Swing Phase)

- **Late Swing Phase Mechanics:** This is a critical period where the hamstrings must eccentrically decelerate both knee extension and hip flexion. As the muscle-tendon length approaches its maximum, extremely high force is required to control the swinging limb before it hits the ground. (4 → 5)
- **Hip Flexors:** These muscles work eccentrically to decelerate the thigh at the end of the swing phase and then switch to concentric action to accelerate the leg forward during the early recovery phase. (1)

3. Force Production and Stability (Stance Phase)

- **Quadriceps:** During the stance phase, the quadriceps function near-isometrically. Their role is to stabilize the knee while producing high force, with very little change in muscle length. (6 → 7)
- **Ankle Stiffness:** The soleus (calf) maintains stiffness at the ankle throughout the stance phase. This stiffness is vital for the Achilles tendon to effectively store elastic energy during contact and release it during push-off. (6 → 7)

4. Physiological and Structural Readiness

- **Muscle Fascicle Length:** Structural factors play a role in how well an athlete can handle the intense demands of sprinting. For instance, longer fascicles in the biceps femoris (part of the hamstrings) improve the muscle's tolerance to high-velocity stretch and force.
- **Specific Conditioning:** High-speed sprinting exposes the hamstrings to unique forces that cannot be replicated through other exercises. Therefore, progressive exposure to sprinting itself is considered the most specific way to prepare the muscles for these demands.

5. Management of Ground Reaction Forces

As a sprinter transitions from the swing phase to ground contact (early stance), force rises rapidly. The ability to handle these rapidly increasing ground reaction forces while maintaining limb control is a key element to maximum velocity sprinting

The Main Mechanism of Most Hamstring Injuries During Sprinting.

The main mechanism behind most hamstring injuries during sprinting involves the muscle being subjected to high force while at a long muscle length. The long head of the biceps femoris is the most affected hamstring muscle due to high-speed limb movement, and injuries typically occur during two specific phases of the sprinting gait:

- **Late Swing Phase:** This is a critical window where the hamstrings are at their maximum muscle-tendon length due to the combination of hip flexion and knee extension. During this phase, the hamstrings must act eccentrically to decelerate the swinging limb, which requires extremely high force. (4 → 5)
- **Early Stance Phase:** As the runner transitions rapidly from the swing phase to ground contact, force rises sharply. The hamstrings must contribute to hip extension while simultaneously managing rapidly increasing ground reaction forces. (6 → 7)

Contributing Factors to the Injury Mechanism

- **Rapid Force Development:** The need for muscle to generate massive amounts of force almost instantaneously puts it at high risk.
- **Fatigue:** When an athlete is fatigued, their force tolerance and coordination are reduced, making the hamstrings more susceptible to strain.
- **Muscle Structure:** Individuals with shorter muscle fascicles in the biceps femoris long head are at a higher risk, as shorter fascicles are associated with increased strain. Conversely, longer fascicles provide better tolerance to the intense stretch and force of sprinting.

There is also a second, less common "stretch-type" injury mechanism which occurs during extreme hip flexion and knee extension, such as during kicking, lunging, or overstretching.

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