DIFFERENT POSTURES OF SPRINTING PHASE

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Abstract

Sprinting is a high-intensity form of running that requires optimal biomechanics, strength, and technique. It involves a cyclic pattern of rapid acceleration and deceleration, with each phase of the sprint contributing to speed and efficiency. Key components of sprinting include proper posture, stride length, and frequency, along with powerful lower body movements that generate force against the ground. The sprinting gait cycle is characterized by phases such as the stance, swing, and flight, each of which influences overall performance. Additionally, factors like ground reaction forces, hip extension, and knee drive play crucial roles in enhancing propulsion and reducing braking forces. Effective sprinting also relies on rapid force development, hip mobility, and timing to optimize speed. Training for sprinting focuses on improving strength, flexibility, coordination, and explosive power to achieve faster times. By understanding the mechanics of sprinting and focusing on proper technique, athletes can maximize their sprinting potential and performance.

1. Introduction:

Sprinters are the epitome of speed, agility, and raw athleticism. They are athletes who specialize in short-distance races. These events demand not just physical power but mental focus and discipline. Unlike long-distance runners, sprinters rely on explosive starts, sharp acceleration, and maintaining maximum velocity over the course of their race. Training for sprinting involves a combination of strength conditioning, explosive drills, and technique refinement, all aimed at shaving off milliseconds and gaining that crucial edge over their competitors. For sprinters, every movement, every stride counts, making them masters of precision and control in the world of track and field. [1]

2. Sprinting:

Sprinting refers to the act of running at maximum speed over a short distance. It is a high-intensity activity that requires a burst of energy and muscular power, typically lasting from a few seconds to a minute, depending on the distance and level of training. Sprinting is primarily anaerobic, meaning it relies on the body's immediate energy systems, particularly the phosphagen system, which provides quick bursts of energy for explosive movements. [1,2]

In sports, sprinting is a fundamental skill in track and field, where athletes compete in races like the 100 meters, 200 meters, and 400 meters. Sprinting requires not only speed but also efficient technique, including body posture, stride length, and arm movement. [1] It is also a vital part of other sports, such as football, soccer, and rugby, where short bursts of speed can be crucial for performance. Beyond athletic competitions, sprinting is also used in interval training, where it alternates with periods of rest or lower-intensity activity to improve cardiovascular health, endurance, and overall fitness. Training for sprinting often involves exercises focused on strength, explosive power, and agility. [3]

To become an effective sprinter, athletes work on various factors such as reaction time, stride frequency (how quickly the feet hit the ground), stride length (how far each step reaches), and acceleration. Proper technique is essential to prevent injury and maximize performance. This includes learning the correct form for starts, running posture, and recovery, all of which contribute to a sprinter's efficiency and speed. [4]

3. 100m sprint:

The 100m sprint is an incredibly short yet intensely demanding race, requiring athletes to demonstrate a blend of speed, strength, agility, and precise technique. Elite sprinters aim to cover the 100-meter distance, utilizing their full athletic potential. The race is not just about raw speed but also involves impeccable timing, balance, and form to secure the fastest possible time while avoiding any risk of disqualification. [23]

3.1 Start phase:

The start phase in sprinting, which occurs before the "On your marks" stage, is all about preparation and positioning. It begins when the athlete approaches the starting line and sets up in their designated lane with the starting blocks. Proper setup is critical for a successful race start, as it helps the sprinter maximize their power and explosiveness right from the first moment. [5]

First, the sprinter places their feet in the starting blocks. The front block is positioned just behind the starting line, while the rear block is placed a little further back. The sprinter places their dominant foot in the front block, ensuring that the foot with the most strength and drive is positioned to give them the best push. The hands are placed just behind the start line for stability, with the athlete maintaining a low and balanced posture. At this stage, the sprinter is focused on getting into the optimal position to launch themselves forward as quickly as possible. The body should be low to the ground, with the head down and the eyes directed forward. The athlete's hips are typically positioned higher than their shoulders, which allows them to use the power from their legs to push off effectively when the race begins. [6]

The start phase requires mental focus and physical readiness. The athlete is not yet moving but preparing to explode into motion as soon as the command "On your marks" is given. This period of stillness allows the sprinter to control their breathing and prepare mentally for the intensity of the race. Proper setup during this phase directly impacts the efficiency of the start and ultimately sets the tone for the rest of the race. [5]

3.2 On your marks phase:

The "On your marks" phase in sprinting is a crucial moment in the start sequence, where the athlete positions themselves for the final setup before the race begins. This phase comes after the athlete has approached the starting blocks and is now ready to take their place for the upcoming sprint. When the starter calls "On your marks," the sprinter moves into a precise, focused position in the starting blocks. The athlete places their feet in the blocks, ensuring the dominant foot is in the front block and the back foot is securely positioned in the rear block. The sprinter's hands should be placed just behind the start line, and their body is set in a low, balanced posture. [7]

The goal of the "On your marks" phase is to prepare the sprinter's body for an explosive start. The body should be positioned so that the athlete's weight is evenly distributed and ready to be pushed forward with maximum power as soon as the race begins. The hips should be higher than the shoulders, and the back should be flat to create a streamlined posture that aids in acceleration. This phase is critical because it helps the sprinter focus on form and balance before the start signal. During this time, the athlete's focus should be on breathing calmly and mentally preparing for the intensity of the race ahead. The hands should be positioned just behind the starting line, ensuring they are close but not crossing it. [8]

The arms should be positioned so that they are perpendicular to the track and spaced about shoulder-width apart. The head and torso need to be aligned, with both being level, forming an imaginary straight line between the two. In this stance, the body should remain relaxed, without any unnecessary muscle tension, allowing the sprinter to remain flexible and ready to explode into motion when the race begins. [7]

3.3 Set phase:

The "Set" position in sprinting follows the "On your marks". When the starter calls "Set," the athlete transitions from their starting position into a more focused, ready stance, preparing for the explosive start. In the "Set" position, the sprinter raises their hips to a higher level than their shoulders, tightening their core and leg muscles in anticipation of the push-off. The legs are bent at an optimal angle, ready to use the stored energy in the muscles for maximum force when the starting pistol goes off. The sprinter's body remains low, with the torso angled slightly forward to allow for a powerful drive forward. [5] The arms remain in position, with the hands gripping the starting blocks, and the head stays in line with the spine. At this moment, the sprinter should focus on relaxation in their upper body to avoid unnecessary tension while their lower body is prepped and ready for action. Your back leg, initially extended, will take the first swift step and move forward. Following that, your front leg will swiftly advance, helping to push you forward. As your hips extend, they will propel you both upward and forward, giving you the momentum to move ahead. [22]

This phase requires mental concentration as the athlete prepares to react immediately to the starting pistol. They must be fully aware of their posture, muscle tension, and timing to ensure they can generate the fastest and most powerful start possible. The "Set" position is all about readiness—allowing the sprinter to explode off the blocks as soon as the race begins. [9]

Fig 1 – Set position [7]

The front leg should be bent at a 90-degree angle, which plays a key role in the efficiency of the start, and we'll explore its importance in more detail shortly. The back leg, on the other hand, should be positioned at an angle of about 120 degrees. This positioning allows for maximum power and push-off when the race begins. [7]

3.4 The position at starting pistol fire:

When the starting pistol is heard, it marks the official beginning of the race. Athletes immediately react by pushing off the blocks with maximum force, using both legs to propel themselves forward as quickly as possible. The starting blocks are equipped with sensors designed to detect any premature movement. If an athlete leaves the blocks too early, the sensors will register a false start, leading to their disqualification from the race. This system ensures that all athletes start at the same moment and helps maintain fairness in the competition. [5,10]

3.5 Acceleration phase:

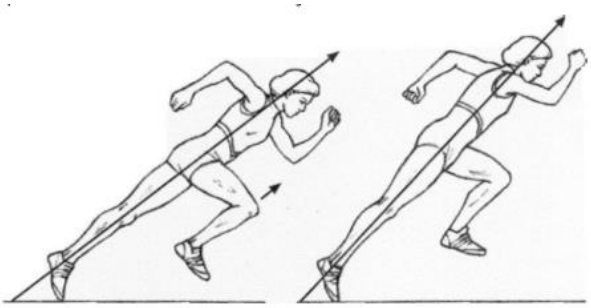

Fig 2 – acceleration phase [14]

The "transition phase" in a sprint, also known as the point of acceleration, marks the moment when your body shifts from applying horizontal forces to predominantly vertical ones. This transition occurs rapidly in real-time, and it's essential to maintain proper form to maximize your force output. [13]

During the acceleration phase, the sprinter's body gradually begins to straighten, and the length of each stride increases. When the ball of the foot strikes the track, the foot should be in a dorsiflexed position, helping to maximize propulsion. The athlete's gaze should remain downward, while minimizing excessive bending at the waist to maintain proper form. Achieving a successful acceleration phase is all about fully extending your legs to produce maximum force into the ground. While this might sound straightforward in theory, it comes with a delicate balance. [21]

The acceleration phase differs from the maximal velocity phase (which includes the drive and recovery phases) in a few key ways. During acceleration, stride length continues to increase, and more emphasis is placed on the front-side mechanics, such as the action of the legs in front of the body. This contrasts with maximal velocity, where the focus shifts to maintaining speed and optimizing stride frequency and length. [12]

Higher force generation typically requires longer ground contact time, yet the nature of sprinting calls for minimizing that contact time as much as possible. This creates a tricky situation for sprinters. [13]

3.6 Drive phase:

In track and field, the drive phase is the first part of a sprint where the sprinter focuses on accelerating quickly before fully standing upright. During this phase, the athlete must generate as much force as possible. At the beginning, the athlete's strides are shorter and faster, but as they move through the drive phase, their strides gradually lengthen. This shift marks the transition toward an upright running posture, which is necessary to reach top speed. A strong drive phase is essential because it establishes the pace for the rest of the race and provides the momentum needed to continue accelerating. [11]

The drive phase of each stride begins when the ball of the lead foot makes powerful contact with the ground and ends when the foot lifts off the surface. At the moment of contact, the athlete's centre of gravity should be slightly behind the lead leg. The impact of the dorsiflexed foot is amplified by the simultaneous extension of the hip, knee, and ankle. This brief contact with the ground continues until the athlete's centre of gravity moves forward and passes over the lead foot. [12]

3.7 Deceleration phase:

Effective deceleration and stopping in sports enable athletes to transition smoothly from acceleration or maximum velocity to a change in direction, depending on the needs of the movement. To decelerate and change direction without completely stopping, athletes must flex their ankles, hips, and knees as each foot strikes the ground. This action increases the time over which force is absorbed and distributed throughout the body. As a result, athletes can reduce their speed and pivot or stop more efficiently, maintaining control during these transitions. [12]

3.8 Final phase:

Mastering the final strides of a sprint is crucial for an athlete's performance. The key to a successful finish is ensuring that the athlete's chest crosses the line, as this determines their official time. During the run towards the finish line, it's essential for the athlete to maintain proper posture and a consistent stride.

In the final moments of the race, the athlete should:

1. Run through the finish line, not just to it. It's important for athletes to avoid slowing down or easing up as they approach the line. To help athletes internalize this, coaches can ask them to imagine that the finish line is several meters farther ahead than it actually is. This mental trick encourages them to maintain their speed and momentum all the way through the finish.

2. Lunge forward and lean through the line. A forward lean or slight lunge at the end of the sprint can make a significant difference in crossing the line with maximum speed. Coaches can simulate race finishes by placing people or objects at different points along the finish line. This allows athletes to practice their final push in a realistic, competition-like environment, mimicking the intensity and urgency of an actual race.

By incorporating these strategies into training, athletes can develop the crucial finishing techniques that help them maximize their performance when it counts the most. [14]

4. Stride length:

Stride length in sprinting is largely determined by the power a sprinter generates during the ground contact phase. This power directly influences the angle of force applied to the ground. When sprinters overstride—meaning their landing foot strikes too far in front of their centre of mass (CM)—it creates braking forces, which slow them down. While it may seem beneficial to try to lengthen the stride, overstriding can actually reduce stride length by introducing these braking forces. The key to improving stride length isn't necessarily about altering technique, but rather about increasing the sprinter's power output. As sprinters enhance their ability to produce more power, their stride naturally lengthens, often as a result of improvements in stride frequency. Therefore, focusing on developing power is the most effective way to increase stride length and sprinting performance. [15]

5. Dorsiflex:

Dorsiflexion, which occurs through the action of the anterior tibialis muscle (located at the front of the shin), plays a key role in running mechanics by lifting the foot. Although this movement may seem relatively simple, it has a significant impact on running technique and can lead to complex issues for athletes. Since the foot makes contact with the ground during running, any movement at the foot and ankle affects the entire kinetic chain, potentially influencing the knee, hip, lower back, and beyond. While dorsiflexion might not be as noticeable during slower jogging speeds, it becomes much more critical as you increase speed, especially in sprinting. The faster you run, the more force you apply, and proper dorsiflexion helps optimize your stride mechanics and force production, making it increasingly important as you approach sprinting speeds. [16]

6. Plantar flexion:

Plantar flexion is a movement at the ankle where the toes point downward, increasing the angle between the foot and the shin. A common example of this is when you push off the ball of your foot while performing a calf raise. This motion is essential for various activities such as walking, running, and jumping. It’s the opposite of dorsiflexion, where the toes are pulled upward toward the shin, like when lowering the heels during a calf raise. [17]

7. Upper body sprinting posture:

In upright sprinting, maintaining an optimal posture is key. The body should remain tall, with the head, neck, and shoulders aligned directly over the hips. A slight forward lean is acceptable, but excessive leaning will disrupt the body's alignment and performance. When the body is bent at the waist or leaning too far forward, the ability to generate force straight into the ground is diminished. This reduction in vertical force leads to slower sprinting times. [18, 27]

7.1 Head:

The position of the head plays a crucial role in your overall posture, which in turn affects the running efficiency. The head should be aligned to the spine to maintain a neutral and efficient posture. The focus should be directed straight down the track to avoid unnecessary movements. Ensure the neck and jaw are relaxed. Keep the gaze forward, looking ahead naturally instead of focusing on the feet. This helps align the neck and spine, promoting better posture. Avoid sticking chin out, as it can throw off alignment and create unnecessary tension in the neck and upper body. By keeping head in neutral, forward-facing position, supporting proper form and improve the stride mechanics.[20]

7.2 Shoulders:

The shoulders should be relaxed and positioned low, not raised toward your ears. Shrugging the shoulders can create tension and disrupt natural sprinting form, reducing efficiency. If the shoulder blades feel closed or the shoulders are pulled back, try to create space in the middle of the back and find a neutral position. This doesn't mean rounding the shoulders or collapsing the torso, but rather settling into a neutral posture with more space between the shoulder blades. If tension is felt higher up, near the top of the shoulders or at the base of the neck, allow the body to relax and open up. Take a moment to find a comfortable, neutral, and relaxed position. [20]

The key when running is to remain relaxed, allowing the muscles to stay loose. This enables the arms to swing naturally, free from tension. Often, tension creeps back in when fatigue sets in or when trying to increase speed. The key is being aware of it, recognizing the tension, and consciously relaxing the muscles again. [20,24]

7.3 Hands and Arms:

When sprinting, keep the palms open rather than clenching fists, though if tend to run with closed hands, focus on staying relaxed. The arm movement should be coordinated with leg movement, ensuring they are in sync to maintain rhythm and balance throughout the stride. They help release tension in the upper body and work in sync with the legs to drive the body forward. Arm movement should focus on swinging forward and backward, rather than across the body, staying within the range of the waist to lower chest. The elbows should form a 90-degree angle. If the fists or forearms become tense, it's beneficial to let the arms drop to the sides and gently shake them to relieve the tension. [25]

7.4 Torso:

The alignment of the torso while running is influenced by the positioning of the head and shoulders. Maintain an upright torso as you reach maximum velocity. Bending or extending hips too much can reduce the range of motion, which in turn limits the speed. Keep a tall, efficient posture to allow for optimal sprinting mechanics. When the head is held up, looking forward, and the shoulders are relaxed and low, the back naturally straightens, allowing for an efficient, upright posture. This position helps maximize lung capacity and stride length. Many track coaches refer to this as "running tall," which means fully extending to your height with a comfortably straight back. If slouching occurs during a run, take a deep breath and allow the body to naturally realign. Upon exhaling, maintain that tall, upright position. In the "Set" position, it is important to establish a block setting based on anthropometric factors that promotes effective hip extension and supports the contribution of the rear leg. During the push-off, a quick extension of both hips and increased force generation are key elements for optimal performance.

[32]

8. Lower Body:

While sprinting, stay on the balls of your feet and push off using your toes. This helps generate more power and maintain proper form. Individuals with stronger lower bodies are able to generate a higher peak ground reaction force. Additionally, those with more lower body strength exhibit a faster rate of force development at the moment of foot strike while running. [19, 29, 30]

8.1 Leg:

While sprinters need to lift their knees high to generate maximum power, distance runners don't require such a pronounced knee lift, as it would be difficult to maintain over long distances. Instead, efficient endurance running involves a modest knee lift, rapid leg turnover, and a short stride. These elements combine to promote smooth, continuous movement without wasting energy. When running with the proper stride length, the feet should land

directly beneath the body. Upon foot strike, the knee should be slightly bent to absorb the impact naturally. If the lower leg extends out in front of the body, it indicates that the stride is too long. [20,26]

8.2 Knee:

To generate maximum power while sprinting, push the knees forward and raise them high, which also helps to extend the stride. Short strides during sprinting limit the full potential of leg extension. By lifting the knees, the legs can reach further distances. The high knee position helps to prepare the body for maximum explosive force when placing the foot. The high knees drill is a fundamental exercise that athletes across various sports, locations, and age groups have likely performed at some point in their training. Typically included in warm-up routines, it serves as a dynamic movement to increase body temperature, blood flow, and muscular elasticity.

To execute the high knees drill, begin by standing tall, applying force into the ground through the balls of the feet, which should be positioned directly beneath the hips. Alternate leg drives, lifting the knees to 90-degree angles at the hips while maintaining proper arm swing. Common mistakes include excessive leaning forward or backward with the torso due to tight hip flexors, striking the ground with a flat foot, or neglecting proper arm swing. [31]

The often-overlooked benefits of performing the high knees drill with accuracy include improvements in running form (such as foot positioning and knee drive), hip mobility, and hip flexor strength. A key focus during the drill should be on foot position at ground contact. In both distance running and top-speed sprinting, it's most beneficial to apply force through the balls of the feet and directly under the hips. This helps to minimize over-striding, which occurs when the foot lands too far ahead of the hip, applying force through the heel or mid-foot. This is undesirable because heel contact with the ground pushes force in the opposite direction, slowing velocity. [20]

A higher knee drive increases the range of motion in which the limb can accelerate before making ground contact. An analogy for this is using a hammer to hit a nail: the more the hammer is pulled back, the greater its acceleration and the more force it applies. A small pull-back results in insufficient force. Similarly, the higher the knee drive, the greater the stretch in the glutes and hamstrings, leading to a stronger contraction during hip extension.

The stretch reflex, a muscle contraction that follows a stretch in the muscle group, is triggered when muscles are actively stretched. This reflex allows for a more powerful contraction due to the tension created within the muscle, improved actin-myosin interaction (the proteins responsible for muscle contraction), and inhibition of the antagonist muscle group. With higher knee drive, the glutes and hamstrings undergo a greater stretch, resulting in a stronger contraction during hip extension. Performing the high knees drill with the Speed Maker encourages the stretch reflex in the hip flexors, leading to greater knee drive. It also provides resistance during hip extension, strengthening the glutes and hamstrings. Since the hamstrings play a crucial role in generating horizontal propulsion, acceleration, and velocity, incorporating hamstring work into all workouts is essential for runners. [28]

8.3 Feet/ankle:

To run efficiently, it's essential to generate maximum force with each push-off. With every stride, the foot should make a light contact with the ground, landing between the heel and midfoot, then quickly roll forward. Keep the ankle flexed during the forward roll to create more power for the push-off. Toe-off marks the start of the swing phase, and as the runner speeds up, less time is spent in the stance phase, causing toe-off to occur more quickly. The timing of toe-off is influenced by the runner's speed. As the foot transitions onto the toes, aim to spring off the ground, feeling the calf muscles driving the movement. The feet should not make a loud slapping sound upon landing. [33]

9. Design consideration for sprinter's garment from the sprinting postures:

Sprinter's garments are specifically designed to minimize drag and optimize the athlete's speed. They are typically form-fitting and made from lightweight, stretchy fabrics that reduce air resistance. This sleek design ensures that the sprinter can move with minimal disruption from the fabric, focusing on maximizing speed. Compression garments, on the other hand, are also tight-fitting but serve a dual purpose: they not only reduce muscle vibration during high-impact activities but also promote better blood circulation. While both types of garments fit closely to the body, the sprinter's outfit is more focused on aerodynamics, while compression garments are more about providing muscle support. Compression garments are engineered with specific compression zones to apply controlled pressure to various parts of the body. These zones differ in intensity depending on the muscle group they are designed to support. For example, compression wear often has stronger compression around the calves, thighs, or hamstrings, areas that experience significant stress during physical activity. [34]

10. Conclusion:

In conclusion, sprinters embody the perfect balance of speed, power, and precision. Their success is a result of countless hours of training, dedication, and a relentless pursuit of improvement. While their races may last only seconds, the preparation and mental toughness required are built over years of hard work. Whether on the track or in training, sprinters continue to push the limits of human performance, inspiring others to break through their own barriers. Ultimately, their journey is a testament to the power of determination and the art of mastering speed.

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