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DEVELOPMENT OF A METHOD FOR OPTIMIZING STRIDE FREQUENCY AND QUANTITY TO IMPROVE THE PERFORMANCE OF SKILLED 400m AND 800m RUNNERS

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ABOUT ARTICLE

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Abstract: Improving running technique is essential for enhancing performance, efficiency, and reducing injury risk. Effective technique includes proper posture, stride mechanics, and breathing. Maintaining a balanced posture—with a relaxed, forward-facing head, relaxed shoulders, and natural arm swings—reduces energy waste and promotes efficiency. Optimal stride mechanics, including cadence, foot strike, and stride length, are vital for speed and control a midfoot or forefoot strike helps distribute impact, while a higher cadence and shorter stride prevent overstriding. Finally, deep, diaphragmatic breathing maximizes oxygen intake and endurance. Coordinated rhythmic breathing, like a 3:2 step-to-breath ratio, enhances oxygen distribution and reduces injury risk. Practicing these elements consistently transforms running into a sustainable, rewarding activity, enhancing both performance and enjoyment for runners of all levels.

Introduction. A lot of us when we are talking about how to run we just run and that is fine because sometimes when we increase a mileage we can start to pick up heels and get injuries due to our habits in or out running form. What a good news is scientific tricks can make a huge difference in running technique if we run more efficiently which make us a faster runner and also will protect us from injuries. Improving running technique can dramatically enhance

performance, efficiency, and injury prevention [9,12]. This is true whether you're refining your form for a demanding sprint like the 400 meters or a middle-distance challenge like the 800 meters. Skilled runners in both events benefit from focusing on stride mechanics, pacing, and strength and mobility. The 400 meters demands speed and anaerobic power, pushing athletes to maintain a rapid pace through refined biomechanics, optimal stride length, and efficient turnover. Skilled 400-meter runners concentrate on explosive starts, powerful strides, and managing fatigue in the final stretch. In contrast, the 800 meters calls for a blend of speed and endurance, requiring athletes to balance pace while preserving energy for a finishing sprint. Skilled 800-meter runners prioritize a smooth, energy-efficient stride, aerobic conditioning, and strategic pacing to sustain a strong, steady effort over two laps. By developing targeted strategies, from foot placement and breathing patterns to mental focus, runners can maximize their performance in both races [1,6]. While the technical demands of each distance vary, a commitment to refining these techniques can make a significant difference on the track, whether for a 400-meter sprint or an 800-meter endurance test.

The aim of this research is to explore and improve running technique for 400 and 800 meters, focusing on stride mechanics, breathing, and pacing strategies to enhance performance and prevent injuries.

Methodology. This study investigates the key factors influencing performance improvement in 400-meter and 800-meter running, focusing on biomechanical adjustments, pacing strategies, and physical conditioning. Participants include skilled 400-meter and 800-meter runners from university-level track teams. Data collection involves both quantitative and qualitative methods, aiming to capture biomechanical metrics as well as subjective experiences.

Participant Selection. A total of 2 skilled runners, evenly split between 400 and 800 meters, were selected based on prior competitive experience and performance times within each event's standards. Informed consent was obtained from all participants, and ethical guidelines were followed to ensure their safety and well-being.

Experimental Setup. Testing was conducted on a standard outdoor track, under similar environmental conditions to maintain consistency across trials. A warm-up and dynamic stretching routine were provided for each session. Participants then completed race simulations and performance drills while their biomechanics and physiological responses were measured.

Data Collection. Biomechanical Analysis: High-speed video cameras captured participants' strides, foot strikes, knee drives, and turnover rates at various stages of the race.

Video data was analyzed to determine each runner's stride mechanics, foot strike patterns, and cadence.

Pacing Strategies: Runners performed 400- and 800-meter trials with varied pacing patterns (e.g., negative splits, even pacing). The effectiveness of these strategies was evaluated based on timing data, overall energy conservation, and finishing strength.

Strength and Mobility Assessment: Leg strength and core stability were assessed through squat jumps, lunges, and plank holds to gauge power and balance, important factors in sustaining performance across both distances.

Intervention and Training Adjustments. A four-week intervention phase allowed participants to incorporate recommended adjustments, including stride mechanics optimization, cadence work, and breathing strategies. Runners performed additional strength and mobility drills tailored to their event. They returned for post-intervention trials to measure performance changes.

Data Analysis. Quantitative data, including stride length, cadence was analyzed using statistical software to determine improvements in performance efficiency, energy use, and endurance. Qualitative feedback on pacing and perceived exertion was coded for thematic analysis to understand subjective responses to the intervention.

Conclusion. By comparing pre- and post-intervention results, the study evaluated how targeted biomechanical and pacing adjustments contribute to improved performance in 400- and 800-meter events. Findings were validated by cross-referencing individual runner feedback and performance metrics, which provided insights into the differential demands of each distance and the efficacy of tailored technique adjustments.

Results of the research. Improving running technique can have a significant impact on performance, efficiency, and injury prevention. Whether you're a seasoned marathoner or a beginner looking to run more comfortably, refining your running form will pay dividends over time [3]. Here are three key ways to improve your running technique: mastering posture, focusing on stride mechanics, and incorporating breathing strategies.

Posture is the foundation of effective running. Poor posture leads to wasted energy, potential injuries, and reduced efficiency. A good running posture begins with keeping your head aligned with your spine, not leaning too far forward or backward. Your head should be upright and relaxed, with your gaze directed forward [7]. Many runners tend to look down at the ground, but maintaining an upward gaze helps keep your spine aligned and improves balance.

Your shoulders should be relaxed and slightly back, not hunched forward. Tension in the shoulders is common, especially as fatigue sets in, so it's essential to consciously release any tightness. Arms should swing naturally from the shoulders, moving forward and backward, not side-to-side. Keep your elbows bent at about a 90-degree angle, with your hands relaxed—some runners benefit from imagining they're holding a delicate object like an egg in each hand. This posture not only enhances efficiency but also reduces the risk of injury by preventing imbalances that can strain the neck, back, and hips.

Stride mechanics, including cadence, foot strike, and stride length, are critical components of running technique. First, let's look at cadence—the number of steps you take per minute. Many elite runners aim for a cadence around 180 steps per minute, though this number can vary based on personal preference and body type. A higher cadence generally results in a lighter, more efficient stride. Practice increasing your cadence gradually by 5-10 steps per minute until you reach a rhythm that feels natural and helps you avoid overstriding.

Foot strike is another essential element. For most runners, a midfoot or forefoot strike is preferable to a heel strike, as it distributes the impact more evenly and reduces the braking effect that occurs when your heel lands first. However, adjusting your foot strike should be done carefully to prevent injury. Aim to land softly with your foot under your body's center of gravity to minimize impact forces.

Finally, keep an eye on your stride length. Overstriding—taking longer steps than necessary—often leads to inefficiency and increases the risk of injury. It's better to take shorter, more frequent steps to maintain speed without increasing the impact on your joints. A slight forward lean from the ankles (not the waist) can also help optimize your stride and keep your momentum moving forward.

Breathing is often overlooked, but it's crucial for stamina and efficiency. Breathing too shallowly, especially during intense running, can limit your oxygen intake, reducing endurance and making you tire more quickly. Focus on breathing deeply from the diaphragm, allowing your belly to expand on each inhale. This diaphragmatic breathing maximizes oxygen intake, which helps prevent side stitches and enhances endurance [2].

A useful breathing technique to try is rhythmic breathing, where you coordinate your breaths with your strides. For example, a 3:2 ratio—inhale for three steps, exhale for two—can help distribute the impact more evenly and reduce the risk of injury, as you're alternating which foot strikes the ground as you exhale. During more intense efforts, a 2:1 ratio (inhale for two steps, exhale for one) may feel more natural. Practicing this rhythmic approach to breathing not only improves oxygen delivery but also helps you develop a more relaxed, controlled pace.

Combining these three aspects—posture, stride mechanics, and breathing—will go a long way in refining your running technique. Start by working on each individually and gradually incorporate them together into your regular runs. Keep in mind that improving technique takes time and patience, so be consistent and allow your body to adapt [8]. With proper posture, efficient strides, and mindful breathing, you'll likely see improvements not only in speed and endurance but also in how much you enjoy running. These techniques can turn running from a strenuous activity into a rewarding, sustainable part of your fitness routine.

Running a 400-meter race requires a mix of speed, endurance, and efficient technique. While skilled runners often have a solid foundation, there are always areas for refinement that can enhance their performance. The 400 meters is one of the most demanding sprints, and slight improvements in running form, strategy, and physical conditioning can make a significant difference in race times. Below are three essential ways skilled runners can improve their running technique for the 400 meters: refining stride mechanics, optimizing pacing strategy, and focusing on strength and mobility.

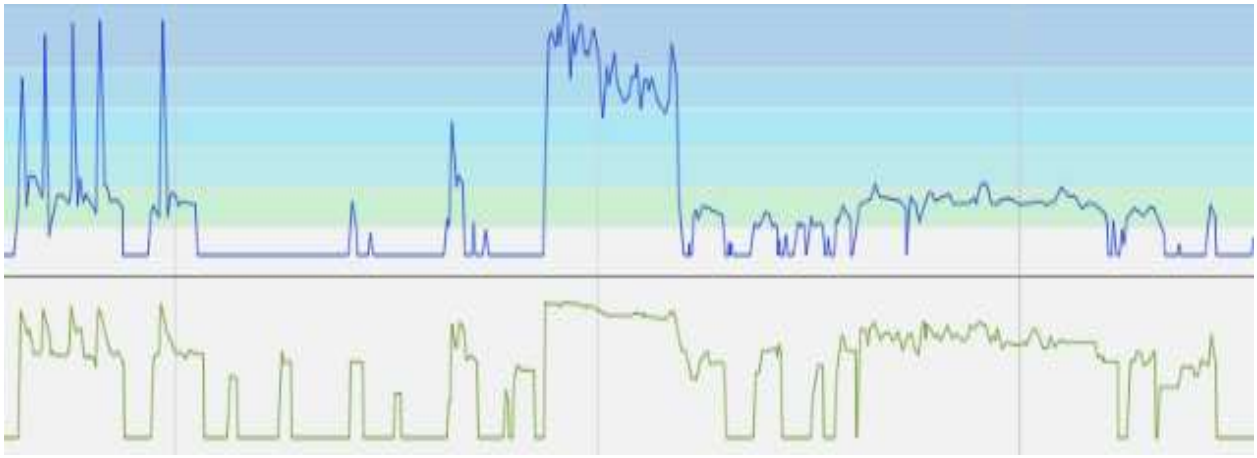

Figure1. Training system for skilled 400 m runners directed to cadence and running tempo improvement

Stride mechanics play a crucial role in maximizing efficiency and speed, especially over the intense, sustained pace of a 400-meter race. Even slight adjustments to stride length, frequency, and foot strike can lead to better performance. Skilled runners should focus on the following aspects of stride mechanics:

One common issue with stride mechanics is over-striding, which can lead to excessive braking forces and wasted energy. To combat this, runners should aim for an optimal stride length that allows their feet to land closer to their center of gravity, reducing impact and maintaining forward momentum. Skilled runners often benefit from working with a coach or using video analysis to find this optimal stride length and identify areas where they may be overextending.

For the 400 meters, a midfoot strike can help runners maintain a balance between speed and stability. Landing on the midfoot, rather than the heel or forefoot, allows for a smoother transition between steps and minimizes the risk of injury. Midfoot striking also contributes to better alignment and helps absorb shock more effectively. Drills like high-knees and stride-outs can train the legs to land in this more efficient position naturally.

Turnover rate, or cadence, is the speed at which a runner's legs cycle. For skilled 400-meter runners, a faster turnover rate without sacrificing stride length can make a significant difference in performance. Drills like quick-feet or speed ladders, combined with running over short distances, can help increase turnover. Practicing fast turnover with a controlled, relaxed upper body also prevents unnecessary muscle tension, which can slow a runner down over the course of a race.

The 400 meters is unique in that it's both a sprint and a test of endurance. Skilled runners can benefit from refining their pacing strategy to avoid burnout while still maximizing speed. The ideal pacing strategy divides the race into manageable segments, helping runners distribute their energy efficiently. Here's how to approach pacing more effectively:

A classic pacing approach divides the 400 meters into four segments of 100 meters each [4]. The initial 100 meters is typically run at around 90-95% of maximum speed, enabling the runner to establish a strong pace without expending all of their energy. The second 100 meters should maintain the same pace while conserving as much energy as possible for the second half of the race.

In the third 100-meter segment, runners should employ a "float phase." This is where the runner maintains speed without pushing for additional acceleration, conserving energy for the final stretch. Skilled runners use the float phase to catch their breath and prepare for the final burst, staying relaxed while keeping good form. Mental focus and breathing techniques can make a big difference in this segment, allowing the body to recover slightly before the last 100 meters.

A well-executed final 100 meters can shave seconds off a runner's time. The key is to stay relaxed, drive the arms, and engage the core to maintain form despite fatigue. Skilled runners should avoid over-striding or tensing up, which can lead to muscle cramps or a breakdown in form. Practicing finishing drills, such as sprints that start from 300 meters and emphasize the last 100, can improve a runner's ability to maintain speed and form at the end of a race.

Strength and mobility are foundational to proper running form and endurance. For 400-meter runners, having powerful, well-conditioned muscles in the legs, core, and upper body can

make a big difference in both speed and resistance to fatigue. Including targeted strength and mobility exercises in training can enhance performance and reduce the risk of injury.

Powerful glutes, hamstrings, and quadriceps are crucial for a strong push-off and explosive sprinting. Exercises like squats, lunges, and plyometric drills such as box jumps or depth jumps build lower body power. Focusing on single-leg exercises, like single-leg deadlifts, can also improve balance and strength in each leg individually, which is essential for an efficient and balanced stride.

A strong core is vital for stability and posture, especially during the intense turns and straightaways of the 400 meters [10]. Core exercises, such as planks, Russian twists, and leg raises, help maintain good running form and allow for better control during the race. A well-conditioned core can also help runners maintain stability and balance, minimizing lateral movement that can waste energy.

Tight hips can restrict stride length and lead to inefficient movement patterns. Skilled runners should prioritize dynamic stretching exercises for the hips, such as leg swings and lunges, before workouts, and static stretching after running sessions. Foam rolling and using a massage gun on tight muscles, particularly the hip flexors, quads, and hamstrings, can help maintain mobility and reduce post-workout stiffness.

Improving the running technique for skilled 800-meter runners requires a nuanced approach, as these athletes already have a solid foundation in speed, endurance, and overall performance. However, refining specific elements of their technique can make a noticeable difference in race results. The 800 meters is a unique race because it combines both sprint and middle-distance strategies, requiring both anaerobic and aerobic fitness. Here are three key ways skilled runners can enhance their technique and ultimately improve their performance in the 800 meters: refining stride efficiency, optimizing breathing techniques, and perfecting pacing strategies.

For the 800 meters, stride efficiency is crucial because it balances speed with endurance. Unlike longer distances, where endurance is the primary concern, the 800 meters demands high-speed performance maintained over two laps. Skilled runners should focus on refining their stride to ensure minimal energy wastage while maximizing forward momentum.

A longer stride can help runners cover more ground with fewer steps, potentially reducing overall exertion [5]. However, increasing stride length can sometimes lead to over-striding, where the foot lands too far in front of the body, which can act as a braking force. Instead, runners should focus on extending their stride through the hip rather than stretching their leg

out in front. By focusing on hip extension and a forward body lean, skilled runners can lengthen their stride naturally without compromising cadence.

The 800-meter distance demands that each footstrike be as efficient as possible. Runners should aim for a quick ground contact time with a strong, explosive push-off to propel them forward. Working on drills that enhance foot strength, such as plyometrics, can improve the effectiveness of push-off. Drills like high knees, bounding, and skipping can train the muscles involved in each phase of the stride, resulting in a more powerful push-off and reduced ground contact time.

The knee drive plays a significant role in stride efficiency, as it helps lift the body and creates a natural forward momentum. Skilled runners should focus on engaging their core to drive their knees forward and upward in a smooth, controlled motion. Additionally, an efficient arm swing helps with balance and momentum, preventing energy wastage. Arms should be swung at a roughly 90-degree angle and used to balance each stride rather than waste energy.

For skilled runners, oxygen delivery is critical in the 800 meters, where both aerobic and anaerobic systems are heavily taxed. Proper breathing technique can help maintain stamina and reduce the risk of fatigue or muscle cramping. Skilled runners should incorporate breathing drills and strategies that optimize oxygen intake and delivery.

Rhythmic breathing, or syncing breathing with strides, helps regulate oxygen flow and reduce tension. Many 800-meter runners adopt a 2:2 or 3:3 breathing pattern (inhale for two or three steps, then exhale for the same count) to maintain a steady rhythm. For the first 400 meters, this pattern is usually manageable, but as the pace intensifies, switching to a quicker 2:1 breathing pattern in the last lap can provide the necessary oxygen for a final push.

Diaphragmatic breathing involves filling the lungs by expanding the diaphragm instead of just the chest [11,15]. This technique maximizes lung capacity and improves oxygen intake. Skilled runners can practice this by lying on their backs and focusing on pushing their abdominals outward on the inhale, then relaxing on the exhale. With regular practice, runners can incorporate diaphragmatic breathing into their runs, allowing more efficient oxygen flow throughout the race.

For skilled runners, the start and finish are critical points where breathing patterns can have a significant impact. A strong, controlled breathing pattern at the beginning helps prevent early fatigue, while a rapid, controlled breathing cadence toward the end ensures oxygen delivery to muscles under stress. Practicing breathing techniques at race pace during workouts can help runners develop instinctive breathing adjustments during races, allowing them to push through the final 100 meters without oxygen deprivation.

The 800 meters is challenging to pace because it requires a blend of middle-distance endurance with near-sprint speed. Skilled runners often benefit from refining their pacing strategy to maximize efficiency over both laps.

Breaking down the 800 meters into four sections can help runners stay mentally focused. For example, runners might plan the first 200 meters as an acceleration phase, the second 200 as a maintenance phase, the third 200 as a pre-kick phase, and the final 200 as a full sprint to the finish. This strategy helps avoid early burnout while providing a structured approach to increasing speed toward the finish [13,16].

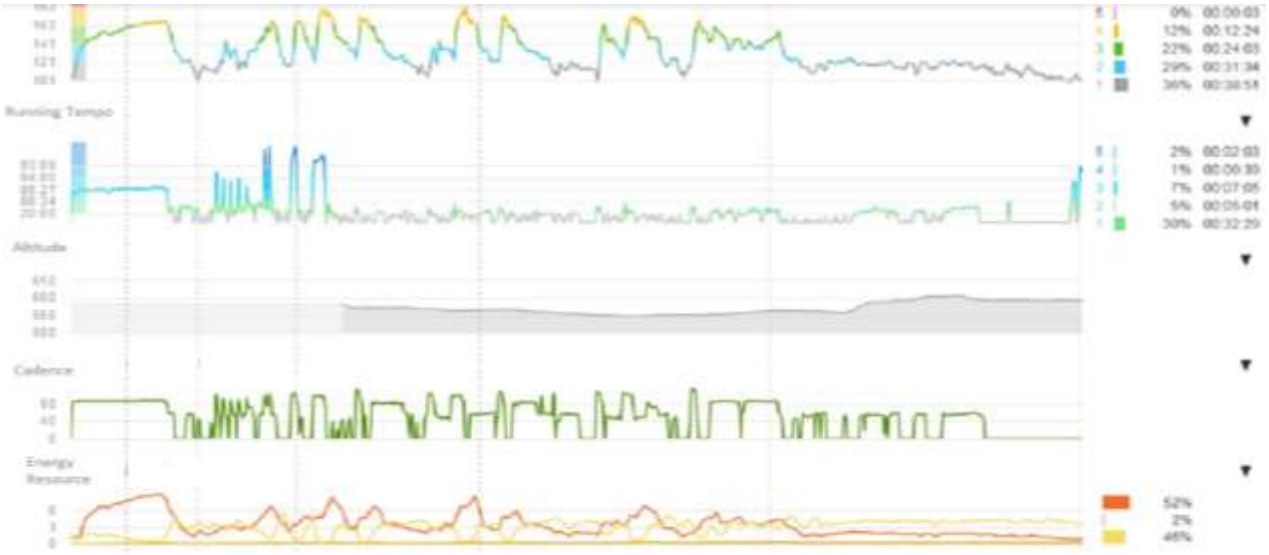

Figure 2. Training system of skilled 800 m runners directed to cadence improvement

A common pacing strategy among elite 800-meter runners is to run the second lap faster than the first, known as a negative split. This strategy can help runners conserve energy during the first lap and use it in the second lap for a strong finish. Practicing negative splits in workouts trains the body to maintain an even pace during the first lap and then shift gears for a faster finish in the second lap.

The last 200 meters of an 800-meter race often separates the winners from the rest. Building sprint endurance is crucial, as this part of the race requires not only the strength to sprint but also the stamina to sustain it after intense exertion. Interval training and race-pace workouts that emphasize finishing fast can develop the necessary physiological adaptations. A mix of 200-400 meter repeats at near-race pace can simulate the demands of the last lap, building strength for a powerful final sprint.

The running techniques for the 400 and 800 meters differ in subtle yet crucial ways, even though both are considered middle-distance events. Skilled runners in each event employ techniques tailored to the unique demands of each distance, optimizing their speed, endurance,

and efficiency to maximize performance. This comparison examines the differences in pacing, biomechanics, energy system usage, and mental strategies utilized by skilled 400 and 800-meter runners.

One of the primary differences between the 400 and 800 meters is pacing. The 400 meters is often referred to as a "long sprint," while the 800 meters is more of an endurance-based middle-distance event, which requires a blend of sprinting speed and endurance. For skilled 400-meter runners, the goal is to maintain a high velocity with minimal deceleration by the final stretch. They typically break down the race into three phases: the initial burst off the blocks, the middle section where they reach a controlled top speed, and the final straight where they must fight fatigue while maintaining form and speed.

In contrast, the 800 meters requires a more conservative start to avoid burning out too early. Elite 800-meter runners often break their race into two halves, aiming to keep the first lap at a controlled pace and reserving energy for a strong finish on the second lap. This requires maintaining a slightly slower pace than in a 400-meter race but with a quicker, sustained turnover compared to longer races like the 1500 meters. Skilled 800-meter runners balance endurance with bursts of speed, allowing them to close the race with a powerful sprint, similar to that of a 400-meter runner in the final 100 meters.

Biomechanical efficiency is key in both events but varies slightly to suit the specific requirements of each race [17]. Skilled 400-meter runners rely on a high knee lift, quick turnover, and an aggressive arm swing that aids in sprinting velocity. This form enables them to achieve rapid acceleration and maintain top speed. Stride length is generally maximized for efficiency and power, with an emphasis on driving forward explosively off each footstrike. To minimize lactic acid buildup, skilled 400-meter runners aim to relax their shoulders and control their breathing as much as possible, especially in the final stretch where fatigue can disrupt form.

For skilled 800-meter runners, the form is slightly less aggressive. While they still need a powerful stride, the focus is more on maintaining a steady rhythm than on reaching top speed. 800-meter runners often have a slightly shorter stride and lower knee lift than 400-meter runners, allowing them to conserve energy over two laps. However, a strong arm swing and efficient hip movement are still crucial. A skilled 800-meter runner's biomechanics are often characterized by relaxed shoulders, efficient breathing patterns, and a steady cadence that allows them to respond to surges and finish with a sprint.

The energy demands for the 400 and 800 meters are another critical distinction. The 400 meters is almost exclusively an anaerobic event, relying on the phosphagen and glycolytic

energy systems. Skilled 400-meter runners draw heavily on anaerobic glycolysis, which provides rapid bursts of energy but leads to lactic acid buildup, resulting in the notorious “lactic burn” toward the end of the race. They rely on maximal power output from their muscles, with limited focus on aerobic capacity.

In contrast, the 800 meters uses a mix of aerobic and anaerobic energy systems. The first 400 meters are often run close to anaerobic threshold, but skilled 800-meter runners rely more heavily on aerobic metabolism as the race progresses. This blend allows them to sustain a high speed over a longer duration. The aerobic system helps delay fatigue by providing a steady energy supply, while the anaerobic system kicks in during surges and the finishing sprint. This balanced energy system utilization is critical for skilled 800-meter runners, who must be able to tap into both reserves for an optimal performance.

Mental focus and strategic decisions play a huge role in both races but differ according to the race’s length and demands. For skilled 400-meter runners, the mental approach is typically centered around controlling intensity and sustaining peak effort. The race is so short that there is little room for tactical decisions, aside from pacing the early phases to avoid too early a burnout [14]. Visualization of each phase of the race and mental cues to stay relaxed and powerful can help skilled 400-meter runners maintain focus.

For skilled 800-meter runners, mental strategies often revolve around pacing and positioning within the pack. Runners must remain focused on conserving energy while keeping a close watch on competitors to avoid getting boxed in or trapped behind other runners. Skilled 800-meter runners often aim to stay in a competitive position during the first lap and execute a final sprint in the last 200 meters. Effective pacing, timing surges, and making bold decisions at crucial points define the mental tactics of skilled 800-meter runners, balancing patience with explosive finishing power.

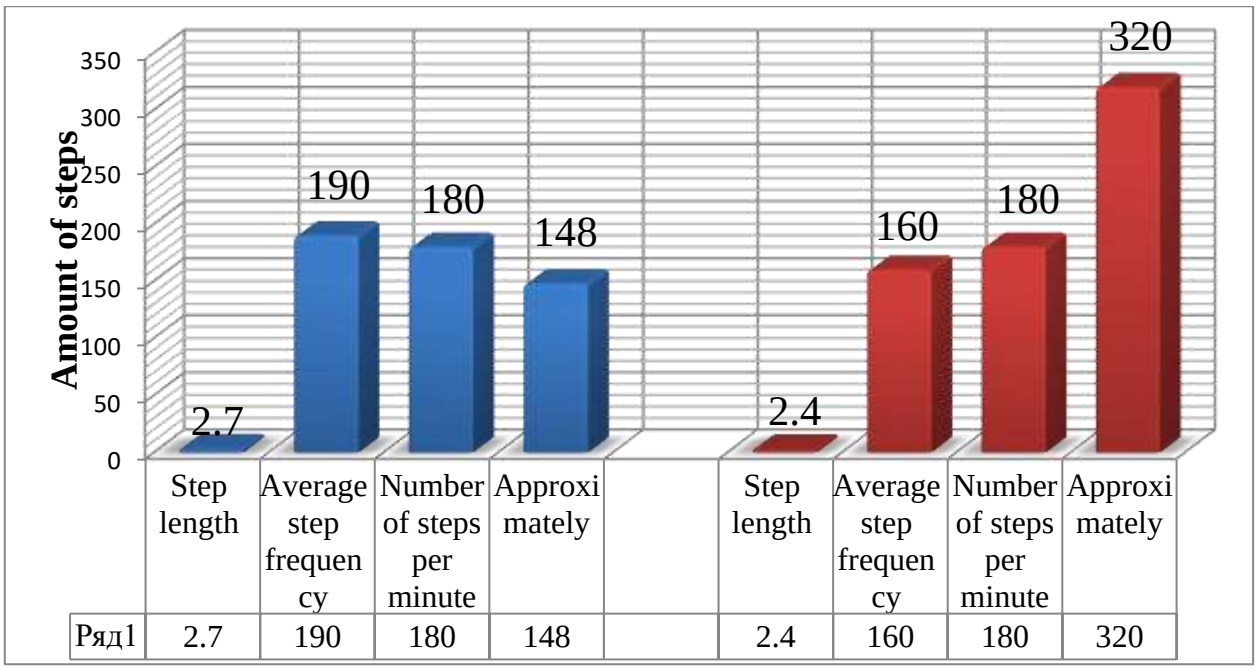

Figure3. Training system of skilled 800 m runners directed to cadence improvement (Blue-400m and Red-800m)

In the 400-meter race, runners typically have a step length of 2.7 meters, with an average step frequency of 190 steps per minute. This results in approximately 148 steps taken over the course of the entire race. The stride length and step frequency can vary slightly depending on the individual's technique and fitness level, but these values serve as a general benchmark for a skilled 400-meter sprinter. With a high cadence and relatively long stride, the runner can maintain maximum speed and efficiency throughout the race, which lasts about 45–60 seconds for elite athletes.

On the other hand, in the 800-meter race, the typical step length is slightly shorter, at 2.4 meters. The average step frequency also decreases to around 160 steps per minute. Despite the reduction in stride length and cadence, the total number of steps for an 800-meter race is considerably higher. With a total of approximately 320 steps, 800-meter runners need to balance endurance and speed throughout the two-lap race. The change in stride mechanics reflects the different demands of the race, where sustaining energy over a longer distance is crucial. Therefore, 800-meter runners may take shorter steps with a more consistent rhythm to conserve energy while still maintaining competitive speed.

Conclusion. Improving 400-meter performance requires a multifaceted approach, focusing on refining stride mechanics, optimizing pacing strategy, and building strength and mobility. Each of these areas, when improved, contributes to a more efficient and powerful running form, allowing skilled runners to push through fatigue and enhance their competitive

edge. By incorporating these techniques into training routines, 400-meter runners can maximize their potential and achieve faster times on the track.

Improving the running technique of skilled 800-meter runners requires targeted adjustments in stride efficiency, breathing, and pacing. By refining each of these areas, runners can conserve energy, enhance speed, and maintain a stronger performance throughout the race. Whether by focusing on efficient strides, optimizing breathing patterns, or developing smart pacing strategies, these adjustments can yield significant improvements in the 800 meters, helping skilled runners reach new personal bests.

In summary, while skilled 400 and 800-meter runners share some common techniques, the unique demands of each distance require different pacing, biomechanics, energy system reliance, and mental approaches. A skilled 400-meter runner focuses on maximizing speed with an efficient stride, explosive start, and strong finish. In contrast, a skilled 800-meter runner combines endurance with speed, maintaining energy through efficient biomechanics and balanced energy system usage while saving strength for a decisive final sprint. The distinct technical and mental approaches reflect the nuanced differences between these two middle-distance events, each requiring precision and adaptability from its athletes.

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