

## Physics behind sprinting

### Background information

**100 m** (one hundred metres) is the shortest outdoor sprint race distance in the sport of athletics. The reigning 100 m Olympic champion is often named "the fastest man/woman in the world".

Sprinters typically reach top speed after somewhere between 50–60 m. Their speed then slows progressively towards the finish line. Maintaining that top speed for as long as possible is a primary focus of training for the 100 m.

The start of the race is decided when the starter fires a gun. The time between the gun and the first kick against the starting block is measured electronically and a reaction time less than 0.1s is considered a false start. This interval accounts for the time for the sound from the pistol to reach the ear of the sprinter and the time taken for the sprinter to react.

For many years after committing 2 false starts a sprinter is disqualified. However this led to the restarting of many major race that resulted sprinters to lose focus. In February 2003, a new rule is passed where after 1 false start, the next person to commit a false start is immediately disqualified. This led to some sprinters deliberately false starting to gain an advantage. A sprinter with slower reaction time might false start, forcing the faster starters to be sure they have heard the bang before starting, losing some of their advantage. In order to avoid such abuse, the International Association of Athletics Federations (IAAF), implemented a change to the 2010 season, where the first false starting is immediately disqualified. This proposal was met with objections when first raised in 2005, since it would not leave any room for innocent mistakes.

The winner of the race is the first sprinter to pass the finish line with his torso.

Fastest 100 metres timing (men):

9.58s, +0.9m/s tailwind, Usain Bolt, Jamaica, 16 August 2009, Berlin World Championship

Fastest 100 metres timing (women):

10.49s, 0.0m/s wind, Florence Griffith-Joyner, United States, 16 July 1988, Indianapolis, US Olympic trials.

### Factors affecting performance

Biological factors affecting runners are:

- 1) Muscular strength
- 2) Adrenaline use

- 3) Anaerobic respiration capacity
- 4) Breathing
- 5) Proportion of fast-twitch muscles against slow-twitch muscles
- 6) Leg length
- 7) Pelvic width

#### Non-biological factors (Climatic conditions)

Climatic conditions are crucial for good performances in sprinting, and a primary climatic condition is air resistance. A head wind will increase air resistance acting on the sprinter, thereby hindering his movement and result in detrimental performances. A tail wind will however boost the sprinters performance as the wind acts as a driving force pushing the sprinter forward and also significantly decrease the effect of air resistance. Therefore, tail wind is capped at a maximum of 2.0m/s for the performance to be eligible for records. This limit is also known as “wind legal”.

Other climatic conditions affecting the performance of the sprinter is the altitude. Higher altitude will have thinner air, thereby providing less air resistance. Although thinner air have a lower partial pressure of oxygen therefore making breathing more difficult, this difference is negligible for sprinting distances because anaerobic respiration occurs during sprints and does not require oxygen. Since there are no limitations on altitude, performances made at an altitude higher than 1000 metres above sea-level are marked with an “A”.

#### History of 100m sprinting

In Athens, the first modern 100-meter dash was held at the summer Olympics in 1896. The tracks were not fast at this time, and the lanes were seperated by ropes. Each runner had their own unique style of running as well as starting, that is, they can start with any stance they prefer.

In 1920, the Olympics were a little better. The athletes shared a similar style of running and there were no longer ropes seperating the lanes. The track condition was still not that great however.

In London, in 1948, the first real starting blocks for the 100 m and 400m races , and accurate wind gauges were added.

More developments have been added since then to improve the condition of the track. Today's tracks are more durable and faster as records are still being broken. Developments have been made to athlete's apparel, including their shoes which are now very light weight, flexible and help the runner to accelerate easier.

#### Forces involved during running

##### Forces acted on the runner:

- 1) *Propulsion*-force exerted by the muscles for forward acceleration
- 2) *Force of wind on runner*- can cause acceleration or deceleration of the sprinter depending on the direction of wind
- 3) *Air resistance*- causes the sprinter to decelerate
- 4) *Gravity*- Can be an advantage or disadvantage

#### Ground reaction force:

Reaction force of the ground acting on the sprinter when his foot interacts with the ground.

- 1) Law of Action-Reaction/ Newton's 3<sup>rd</sup> law: For every applied force there is an equal and opposite force. When the sprinter's feet presses onto the track, the track applies an equal and opposite force on the leg of the sprinter, thereby allowing the athlete to move forward.



Effect of ground reaction force on the runner.

- 2) Frictional force: The force that acts parallel and in the opposite direction of the runner, thereby opposing his motion. Occurs when the track and sprinter's feet interact and the normal force between them.

#### Gravity

Gravity can be an advantage or disadvantage to the sprinter's performance. Although gravity causes friction between the track and the sprinter's feet, sprinters have adapted to use gravity as an advantage. To do this, the sprinter leans forward. This allows gravity to work with them as leaning causes gravity to pull the sprinter forward, and make motion of the legs easier as well. By leaning properly from the ankles and not the waist, sprinters are able to run faster and more easily.

## Sprinting technique

### Pre-race start:

- Blocks correctly positioned in the lane
- Correct distances from the start line to the front and rear blocks
- Foot blocks at the correct angles
- Blocks firmly located in the track
- Athlete must be relaxed and focused on the race

### On your mark:

- Feet placed correctly on the blocks.
- Fingers behind the line.
- Fingers form a high bridge.
- Hands evenly positioned slightly wider than shoulder width.
- Shoulders back and vertically above or slightly forward of the hands.
- Arms straight but not locked at the elbows.
- Align head and neck with the spine.
- Eyes focus 1-2 metres ahead on the track.
- Breathe gently.
- Face and neck muscles relaxed.

### Get set:

- Hold the breath.
- Raise hips slowly to a position above the shoulders.
- Align head and neck with the spine.
- Eyes focused on the track one or two metres ahead.
- Shoulders vertically above or slightly forward of the hands.
- Front leg knee angle approx. 90 degrees.
- Rear leg knee angle approx. 120 degrees.
- Feet pushed hard back into the blocks.

### Bang:

- Exhale sharply.
- Drive the arms hard and push forward.
- Extend the whole body so there is a straight line through the head, spine and extended rear leg - body approx. 45 degree angle to the ground.
- Eyes focused on the track 2 to 3 metres ahead.
- Run out of the blocks - do not step or jump out of the blocks.

### Drive Phase/ Acceleration Phase (0-30m)

- Drive the back leg forward keeping the heel low until the shin is approx 45° to the ground and then drive the foot down hitting the ground just behind the body's centre of mass.
- Over the next 7-8 strides (approx. 10 metres) increase the angle of shin of the front leg by 6-7° per stride, before it is driven down, so that by the 7-8 stride the shin is vertical.
- Over the first 7-8 strides the whole body angle will increase from 45° to approx. 30° degrees by approx. 2° per step.
- After the first 7-8 strides you will be at approx. 70% of your maximum velocity.
- Eyes focused on the track to keep low to allow the build up of speed.
- Forward lean of the whole body with a straight line through the head, spine and extended rear leg.
- Face and neck muscles relaxed (no tension).
- Shoulders held back and relaxed, squared at all times
- Arms move with a smooth forward backward action - not across the body - drive back with elbows - hands move from approx. shoulder height to hips.
- Elbows maintained at 90 degrees (angle between upper and lower arm).
- Hands Relaxed - fingers loosely curled - thumb uppermost
- Legs - fully extended rear leg pushing off the track with the toes - drive the leg forward with a high knee action with the knee pointing forward and with the heel striking under the backside (not the back of the backside as the knee is low and pointing down to the ground) - extend lower leg forward of knee (rear leg drive will propel the foot forward of the knee) with toes turned up - drive the foot down in a claw action with a ball of foot/toe strike on the track vertically below the knee - pull the ground under you into a full rear leg extension - (elbow drive assisting the whole action).
- Run on the ball of foot/toes at all times - feet pointing forward straight down the lane.
- Elbow drive commences just before rear leg drive.
- Fast leg action, good stride length allowing continual acceleration.
- The drive is maintained for first 20-30 metres (approx. 16-17 strides) at the end of which the body straightens with a slight forward lean.
- At the end of this phase you will be at approx. 90% of your maximum velocity.

#### Stride Phase (30-60m)

- Smooth transitions from drive phase to stride phase.
- Eyes focused at the end of the lane - tunnel vision.
- Hold head high and squared, aligning with spine.
- Face and mouth relax, no tension.
- Chin held down, not pointing outwards.
- Shoulders held down and do not hunch back, both relaxed and squared
- Smooth forward backward action of the arms- not across the body - drive back with elbows - brush vest with elbows - hands move from shoulder height to hips for men and from bust height to hips for the ladies
- Elbows held at 90 degrees at all times (angle between upper arm and lower arm)
- Hands relaxed - fingers loosely curled - thumb uppermost
- Slight forward rotation of the hip with forward leg drive to help extend the stride
- Legs - fully extended rear leg pushing off the track with the toes - drive the leg forward with a high knee action with the knee pointing forward and with the heel striking under the backside (not the back of the backside as the knee is low and pointing down to the

- ground) - extend lower leg forward of knee (rear leg drive will propel the foot forward of the knee) with toes turned up, stepping over the knee of the lead leg - drive the foot down in a claw action with a ball of foot/toe strike on the track just behind the body's centre of mass - pull the ground under you into a full rear leg extension - (elbow drive assisting the whole action)
- Keep on the ball of foot/toes with the feet pointing forward straight down the lane
  - Appearance of being Tall, Relaxed and Smooth with maximum Drive
  - At or close to the end of this phase you will have reached your max velocity

### Lift Phase (60-100m)

Around 50-60 metres maximum velocity will be reached and now we start to slow down. Technique is the same as the Stride Phase but with emphasis on:

- High knee action (prancing)
- Leg action fast and light as if running on hot surface
- Fast arms - more urgency
- Hands slightly higher at the front

### Physics of running

To understand the basic physics of running, you can think of your limbs as pendulums. A pendulum's velocity depends on the length of the pendulum, not the mass at the bottom. If a pendulum is shorter, the speed of the mass at the bottom is faster.

The period of a pendulum is dependent on its length and the acceleration of gravity. Therefore, the time taken for a complete cycle of a period of a pendulum is

$$T = 2\pi\sqrt{\frac{L}{g}} \text{ -----(1)}$$

Think of your feet as the mass at the end of the pendulum. Then assume that your legs are the pendulums. In order to shorten the pendulum, you bend your knees. This is very simple, and obviously you have realized that it is very difficult to run with your knees locked. Therefore, you will run faster if your knees are bent. The same can be said for your arms. Because the length is increased, when we sub in the length in to the equation (1), we can see that the period also increases.

### Start Phase

#### History of sprint start

The 100 meter dash was always one of the most exciting events at the Olympics. It traces back to the original Olympics in Greece. The sprint start of the race has changed frequently every few decades from then till present. Different methods have been developed to enhance a sprinter's start by introducing the starting blocks. These have allowed for record breaking times and have

improved overall performance. Here is a brief history of the evolution of the sprint start in the Olympic Games:

-In the original Olympics the Greeks began the races standing upright. They placed their toes in a stone starting sill at the start line.

-Later a starting gate or husplex was used to prevent false starts. The gates were similar to those used in horse racing today.

-Blocks for a crouched start were first used in the Olympics at the 1948 Olympics in London. Starting blocks had been used before this in the 1920's but they were used outside the Olympics.

## The Crouched Start

The 100 metre dash involves a lot of physics and the athletes have learnt to use some of this physics to their advantage, helping them to achieve in this sport.

The first, and probably the most important part of the race, is the start. Over the years the sprinters have changed the way they start the race in order to have the best acceleration and fastest times.

Today the crouched start is used. The reason that a crouched start is used other than a standing start is because a crouched start is more effective. It is more effective because it puts the sprinter in a position where they have to accelerate very quickly or else they will fall because their center of gravity is forced to move ahead of their feet, allowing them to accelerate.

### Types of crouched start

There are three main types of crouched starts. The difference between these starting positions is found during the "on your marks" part of the start. The "On your marks" part of the race is when the sprinter is in the starting blocks and they are in their very first phase of the start. The hands of the sprinter are shoulder width apart, their knees are bent with the knee of the back leg on the ground and their feet are on the starting blocks. The start has three phases: on your marks, get set, then the whistle or gun.

The horizontal distance between the toes of the front foot and the toes of the back foot, when the sprinter is in this position, is what changes. Basically it's just the distance between your front foot and back foot in the starting blocks.

#### **BULLET START**

*The first type of sprint start is called a bullet or bunch start . The toes of the back foot are about level with the heel of the front foot . Both of the feet are placed well behind the starting line. The toe to toe distance is said to be 25 to 30 centimetres. In this start, your feet are closest together, compared to the other starts. Because your feet are close together, your legs and body are "bunched" together. That is why it is called the bunched, or bullet start.*

#### **MEDIUM START**

*The second type of sprint start is called medium start. In this the knee of the back leg is opposite the front foot. The toe to toe distance said to be 40 to 55 centimetres. In this start, the feet are closer together than the elongated start but farther apart than the bullet start. Its in the middle. That's why it is called the medium start, because it is in between the other two.*

#### **ELONGATED START**

*The third type of sprint start is called the elongated start. The sprinter has their knee of the back leg level, or slightly behind the front foot's heel. The toe to toe distance is 60 to 70 centimetres. In this start, your feet are spread out farther than the other two. Your back leg is stretched or elongated, behind you.*

Which start is the most effective in giving you the best velocity?

In order to have a good velocity, you need to have a good IMPULSE off of the blocks. Impulse is the force acting over a period of time. In this case, it would be the force your feet pushes against the block over the time at the beginning of the race to allow you to accelerate to the fastest initial velocity.

#### Experiment to find out which is the best type of start

##### PURPOSE:

To study the three different crouched starts and to determine which is the most effective in achieving the greatest impulse giving the sprinter the best velocity out of the starting position.

##### MATERIALS:

- stopwatch
- measuring tape
- running track

##### THEORY:

We have to use two different formulae in this experiment. Here is an explanation of them.

$$v=d/t$$

This is the formula for velocity. Velocity is the roughly the same as speed. The only difference is that velocity has direction, where speed doesn't. Velocity is the quotient of the sprinters displacement (distance from the starting position) and the time it takes to travel this distance.

$$\mathbf{I = F \Delta t = m \Delta v = \Delta p}$$

This is the impulse momentum formula. You're probably wondering what its all about, but when its broken down it can be very simple.

first of all:

Impulse is equal to the force acted over time (as already mentioned).

Since we cannot determine the force very easily, we are going to use another approach. Impulse is also equal to the change in MOMENTUM ( $p=mv$ ). Momentum is the product of the object's, or in this case the sprinter's, mass and velocity.

Because it is easier to determine the runner's mass and velocity, we will be using this formula, the change in momentum, to determine impulse.

#### PROCEDURE

- 1)First of all, find a smooth flat running surface.
- 2)Then measure out a distance of 10 m from the starting line (We only need 10m because we are finding only the impulse during the start, and not the whole race).
- 3)Then have the runner get into the bunched start at the starting line. The bunched, or bullet start, is the start which your front foot and back foot are closest together in the starting position.
- 4)Then have another person at the finish line (10 metres away) to time the runner's first portion of the race.
- 5)Then have the runner in the bunched start practice sprinting to the 10 metre line at least three times to insure that they are able to perform it.
- 6)Then time the person, using this start, three times.
- 7)Then move on to the medium start. This is the start where your feet aren't close together, but they aren't far apart either. The toe to toe distance is approximately 40-55cm's.
- 8)Have this one practiced then record the times of three trials.
- 9)Then repeat the same experiment for the elongated start. The elongated start is the one in which your back foot is furthest behind the front one.
- 10)After the times for the nine trials have all been recorded, find the average time it takes to run the 10 metres for each start.
- 11)Then determine what the velocity was for each of the starts using the velocity formula:  
 $v=d/t$

Fill in the distance(10 metres) and the average times for each start to determine the velocity.

12)After, determining the velocity for each start, you can determine the change in momentum. To do this, have to find the momentum before and after. You also must find the mass (in kilograms) of the person running.

To find the initial and final momentum, fill in the velocity and mass for each of the starts into the following formula.

$(mv)_f - (mv)_i = \text{change in momentum}$

m=mass v=velocity f=final i=initial

13)Once the change in momentum for each of the sprint starts is calculated, you have the impulse. (this is because the change in momentum is equal to the momentum)

14)Then determine which start gives the greatest impulse. Then you will know which start allows for the greatest force over time resulting in the best velocity out of the blocks.

### Results

Generally, the medium start is the start that allows sprinters to produce the greatest impulse allowing them to get the greatest possible velocity when leaving the blocks.

In the bullet start the sprinter is only in contact with the blocks for a short time , thus unable to produce a good force in this time. This implies that they do not have a good impulse. Therefore, the sprinter will not be able to achieve the best possible velocity.

With the elongated start the sprinter has contact with the blocks over a greater time but because of the position they are in they cannot produce a good force on the blocks. The feet are too far apart which affects the balance of the runner. They are unable to push off the blocks well enough to produce the best possible velocity.

When starting in the medium position the sprinter is in a good position to exert a good force on the blocks and the runner has more time than the bullet start to push off the blocks.

### Acceleration phase

The acceleration phase is the most important phase in a race. During this phase, after the sprinter has left the blocks, the athlete increases the length of their stride and decreases the amount of strides taken per second.

Men usually have a rate of 4.6 strides per second and women a little more with 4.8 strides per second.

Professional male sprinters reach their maximum speed at about the 60-70 metre mark .  
Professional women sprinters reach their top speeds at about 50-60 metres.

The acceleration phase differs at different levels of competition. Top runners usually cover 20-30 metres at top speed, that is, maintaining maximum speed for 20-30 metres without slowing down.

### Deceleration phase

The last 10 to 20 metres of the 100 m dash are described as the deceleration phase due to fatigue(tiredness).

Even though it is said to be the deceleration phase it is being noticed that top athletes are becoming able to maintain their maximum velocity for longer intervals allowing them to pass the finish line with a higher speed. Sprinters have improved a great deal, but there is still deceleration (slowing down) at the end of the race. Just not as much.

The competition rules at the finish line are that the final time is calculated from when the trunk of the athlete passes the finish line.

Therefore this is why we see athletes falling at the end of their race. They lean forward at the end. Because they are travelling with a great deal of momentum that has built up over the race, they are propelled downward and fall.

### Physique required for a sprinter

While technique is important to the success of a sprinter, muscle strength and the ability to generate power are the overriding considerations. Beginning with the thrust of the runner out of the starting blocks, the entire body of the sprinter will be used to achieve maximum speed—the legs are the primary source of muscle power, with the arm motion an important thrust and counterbalance to the leg action. This ability to generate power means that all elite-level sprinters tend to possess a well-developed, muscular physique. Sprinters also invariably possess a greater number of fast-twitch muscle fibers as opposed to slow-twitch fibers; fast-twitch fibers are those where the neuron, the component of the nervous system that regulates an individual group of muscle fibers within a muscle structure, are "firing," or directing the fibers to move 10 times more quickly than those in the adjacent fibers. Slow twitch muscles are however, required for long distance runners.

The strength of the runner has a secondary consideration once the runner has left the starting blocks. The runner must continue to fully extend their stride without over-striding; the optimum placing of the feet with each stride is at a point in relation to the runner's body where the center of gravity of the runner remains exactly midway between the runner's feet. A shortened stride to endeavor to drive the legs harder and generate greater power will be counter-effective, due to the loss of distance covered by the shorter stride. There is no perfect stride length, as the height and build of the runner will be the determining factor; but as a general proposition, a taller, powerful runner will tend to be more efficient in the sprints than a shorter, powerful runner.

The speed of a sprinter is a function of stride length as opposed to stride frequency; every sprinter will determine the appropriate relationship between those two factors, depending on the size of the runner. Stride frequency, also described as stride turnover, is the cadence that the runner can establish once top speed after the start is established. Runners who over-stride sacrifice the distance achieved with each stride for running efficiency.

Thus sprinters requires an overall well developed body in order to perform well, legs to accelerate and maintain speed, arms to counterbalance the leg motion, core (back and abdominal) muscles to stabilize and also ensure fluidity in the sprinter's movement. Specifically, the sprinter requires highly developed fast twitch muscles in these parts especially arms and legs. Fast twitch muscles are muscles which the myosin are able to split adenosine triphosphate (ATP) molecules very quickly, providing it with glucose very efficiently, and enabling it to contract and develop tension at 2-3 times the rate of slow twitch fibers

During the acceleration phase, the quadriceps, gluteals and upper-body have a very important role to play in the development of force. While maintaining top speed, the hamstrings, gluteals and hip flexors have more of an important role to play than the other muscle groups. Therefore, it is important to develop these parts of the muscles with resistance exercises such as squats.

### Sprint training

50 years ago, the relationship between running success and overall physical strength was poorly understood; it was believed that intense running workouts, conducted using varying speeds and surfaces, was the key to better performance.

Modern sports science has confirmed the significant benefits of strength training in running, across all running disciplines. Sprinters require the development of maximum explosive power to drive themselves from the starting blocks, and the strength to maintain their speed through to the finish. Therefore, looking to resistance training that facilitates the development of overall muscular strength. The arms and the shoulders of a sprinter are essential to maintaining the counterbalance to the thrust of the legs on each stride as the athlete powers through to the finish.

Strength training must also be assessed in terms of how the runner will be approaching the competitive season. All sports training, to be effective, should be "periodised." The athletic season, typically assessed with reference to the entire calendar year, is subdivided into

1. the competitive season,
2. the preseason,
3. the postseason, and
4. off-season.

Each of these periods may be further defined to take into account any factor that might impact on the quality or extent of training or competition. A period of travel, or academic or employment obligations are such factors. Within each period, the athlete sets training or competitive objectives. As a general proposition, strength training for running will be more

important in the off-season and preseason than during the competitive season, but importance will be balanced against all other physical requirements.

The strength exercises useful to the sprinters and the hurdlers will be emphasized during the buildup and preseason; given the importance of strength to success, most athletes in these disciplines will continue with a modified degree of strength training throughout the year. These athletes will generally embark on strenuous free weight and resistance machine programs that engage the upper and lower body. Traditional routines such as bench press, curls, squats, leg press, and various extension exercises are useful. Sprint athletes also use resistance training in the form of stationary starts pulling a weighted object or employing the drag of a small parachute. These exercises have the additional advantage of simulating an aspect of competition while providing strength development.

All sprint athletes benefit from plyometrics exercises to assist with the development of explosive power in the start blocks. Plyometric training is a type of exercise training designed to produce fast, powerful movements. Plyometric movements, in which a muscle is loaded and then contracted in rapid sequence, use the strength, elasticity and innervation of muscle and surrounding tissues to jump higher, run faster, throw farther, or hit harder, depending on the desired training goal. Plyometrics is used to increase the speed or force of muscular contractions, providing explosiveness for a variety of sport-specific activities. Therefore, it is very important in training the sprinter to “explode” forcefully off the starting to have a good acceleration.

For all runners, strength training must be accompanied by flexibility and stretching exercises. Running, due to its precise and repetitive nature, creates a naturally inflexible muscle environment. Ideally, the runner should stretch before and after all runs; the same routines should be completed before and after all strength training.

### Training programme

The program involves training three times a day on Monday, Tuesday, Thursday, and Friday; Saturday is reserved for a single specific workout. The time frame recommended use is the following:

- **1st Workout** - 10:00 a.m... 20-45 minute active warm-up, max velocity sprint mechanics, plyometrics/bounding, and a cool-down of 10-15 minutes.
- **2nd Workout** - 3:00 p.m... 20 minute warm up, main workout/general conditioning, 10-15 minute cool down.
- **3rd Workout** - 5:00 p.m... Weights

☒ ...Saturday workout is typically late morning or early afternoon.

### Full Warm-Up

For 30 meters:

- Alternate buildup going down with a skip coming back, (4x30m).
- Skipping forward with arms swinging across body.

- Skipping forward with alternating arm swings up/down.
- Skipping backwards with heel raises.
- Skipping backwards with high knees.

**30m build up.**

- Side skipping with arm circles... down and back.
- Cariocas emphasizing fast thigh drive to the ground.
- Rear kicks.
- Running backwards emphasizing a long reach.

**30m build up.**

- Skipping high knees up and out.
- Skipping high knees up and out going backwards.
- Skipping lateral straight leg.
- Skipping lateral straight leg backwards.
- Skipping with spins.

**30m build up.**

- Jumping jacks moving forward to 15m, then a jog for the next 15m.
- Jumping jacks with high knees clapping under knees.
- Straight leg bounding.
- Toe touches.

**...The next section of the warm-up is done with 15 meters...**

- Walking on toes.
- Walking on heels.
- Side stepping toes then heels... left and right.
- Walking pulling knee to chest.
- Walking opposites... elbow to knee.
- Walking swinging leg up and touching toes.
- Walking Quad/Glut holds.
- Cross over jumping jacks.

**...The following lunges are done with 7 repetitions on each leg...**

- Static lunges (alternating).
- Backward lunges.
- Front lunge with opposite elbow reaching to leg extended.
- Diagonal lunge with opposite elbow reaching to leg extended.
- Leg swings front to back.
- Leg swings side to side.

**1<sup>st</sup> workout sprint and plyometric drills**

- 1 - Ankling (toe up - heel up - step over opposite ankle).
- 2 - Heel raises (toe up - heel up - heel to hamstring)... NOT butt kicks.
- 3 - Alternating L&R fast leg cycles.
- 4 - Double cycles, LL&RR.

5 - Continuous R cycles.

6 - Continuous L cycles.

...Each drill is done for 30 meters, 2-4 times on each leg with around 60-90 seconds rest in-between.

Plyometric specific

1 - Straight leg bounding.

2 - Alternating single leg bounds.

3 - "Skip-bounds" for height.

4 - "Skip-bounds" for distance.

5 - 42in. box jumps 4x5.

6 - Standing long jump for distance.

☒ ...Except for the box jumps, each exercise is done three times

## 2<sup>nd</sup> workout General Conditioning

### Monday-

-Sprints 60m 3 sets of 3

-2-3 minutes rest between each rep, 10 minute rest between each set

-Work on form and technique from the morning workout

-Hill sprints 100m 5-7 reps

-4 to 5 minutes rest between each rep

-Hill preferably inclined 20 to 40 degrees

### Tuesday

-Dumbbell Arm swings 10 sets x 60 secs

-5lb to 25lb, depending on gender and strength

-1 set = 60secs swings + 60 secs rest

-1<sup>st</sup> 40-45 secs brisk pace, last 15-20 secs all out sprinting of arms

-Bulgarian dips 3 sets each leg

-Using the single leg squat positions have your back foot on a chair, and your front foot extended out in front of you. Begin by taking 30 seconds to GRADUALLY go down into a parallel position, and then hold for another 30 seconds. At 1 minute, begin slowly rising for 30 seconds until you're half way up, hold for 15 seconds, then spend the final 15 seconds finishing until your front leg is locked out and you're standing again. Now do that to each leg twice, never taking more than 2 minutes rest in-between each set.

**Wednesday-** rest and recover

### Thursday

-Same as Monday

### **Friday**

-Hill sprints 100m 8 reps

-Hurdles 120m- to train explosive power by jumping over steeples

### **Saturday**

-recovery workout

-cycling, jogging, swimming, skipping rope

3<sup>rd</sup> workout weight lifting

Monday and Thursday focusing on lower body, Tuesday and Friday focuses on upper body. Use suitable weights for each exercise depending on gender and strength.

### **Monday**

☒ Snatch - 3x6

☒ Squat - 5x5

☒ Straight legged dead lift - 3x5

☒ 1 leg alternating curls - 3x8

☒ Seated calf raises - 3x8

☒ Ab/Ad machine - 3x8

### **Tuesday**

☒ Dumbbell bench press - 3x10

☒ Dumbbell military press - 3x8

☒ Pull downs - 3x8

☒ Bicep curls - 3x8

☒ Triceps extensions - 3x8

☒ Forearm curls – 3x8

Wednesday rest

### **Thursday**

☒ Power clean "pulls" - 3x6

☒ Squat - 3x8

☒ Power Shrugs - 2x6

☒ Lunges - 3x8 View

☑ Ab/Ad machine - 3x8

☑ Seated calf raises - 3x8

## Friday

Bench pull - 5x5 (Like T-Bar rows but by lying on a bench with a barbell underneath.)

Dumbbell push press - 3x8

Dumbbell bench press - 3x8

Bicep curls - 3x8

Forearm curls - 3x8

## Physical aids

There are few physical aids that will affect the sprinters' performance, but those that are available are very effective in training the specific muscle parts.

**Leg weights-** Used doing resistance exercises. Leg weights are weights strapped onto the user's legs to add resistance to his movements. These weights enhance the person's leg strength as he will require more effort to exercise. Also, leg weights can be used during jogging or walking. This boost leg strength and power so the sprinter will be able to run faster when without the weights.

**Resistance bands-** These bands are strapped slightly above the knees and can be a great help in developing the hip flexors. It can be worn doing any exercise and applies resistance when the user moves his legs. This will generate elasticity and the ability to contract and relax under pressure, and is one of the only ways to develop the hip flexors.

## Diet

Short distance running are the sprinting events 400m and below. At these short distances muscular power and anaerobic metabolism come into play and there is no endurance element. Training as a short distance runner will involve weight training 3-4 times per week as well interval training along with sprint training. Leg strength is vital, as a good start off the blocks can make all the difference.

Sprinters usually carry a higher than average lean muscle mass, and power to weight ratio is very important. Following a meal plan like the one below will be ideal for a typical day's training, and carbohydrate loading pre-event is also advised in order to maximise the muscle and liver carbohydrate stores. Supplementation with the sports supplement creatine monohydrate may also be worth considering. Proteins is also vital in the building of muscles for increased performance.

It is recommended for a sprinter to take 6 small meals per day instead of the conventional 3 heavy meals a day. This keeps your insulin levels more stable and allows you to be in a fat burning mode for a larger percentage of the day. If you eat the traditional 2-3 large meals per day, you have much bigger swings in your blood sugar and insulin levels. After a large meal, your blood sugar will spike much higher than compared to smaller meals, and the

subsequent insulin surge will have your blood sugar crashing to lower than normal levels, leaving you hungry and fatigued until you eat your next feast.

### Meal plan

Breakfast	Porridge: 75g oats + tbsp ground linseeds + 250ml skimmed milk + tsp sugar 2 slices granary bread, toasted + olive oil based spread + natural crunchy peanut butter 1-2 boiled / scrambled eggs 250ml fresh fruit juice
Mid-morning	50g (dry weight) brown basmati rice + tbsp sweet corn/peas + 100g tuna Small handful mixed nuts & seeds Item fruit Mug green tea
Lunch	Sandwich made with granary bread + olive oil based spread with lean ham/chicken or large mackerel fillet 100g mixed nuts, seeds & dried fruit Mixed salad Low fat, low sugar yoghurt
Drink Mid-afternoon	Large handful mixed nuts Large banana Mug green tea 30 minutes pre-training 2-3 oatcakes 20g whey protein 100g mixed nuts, seeds & dried fruit Water
Running / gym training	Sip plenty of water <i>or</i> isotonic drink where possible
post training	25g whey protein + 20g dextrose in water
Evening meal	Lean fillet steak <i>or</i> chicken breast <i>or</i> fish + herbs to taste Boiled new potatoes <i>or</i> basmati rice <i>or</i> dry roasted sweet potatoes <i>or</i> whole wheat pasta Loads of vegetables Low fat, no added sugar yoghurt Drink
Mid-evening	Unsweetened muesli + 200ml skimmed milk Item fruit Drink
pre-bed	25g whey protein in 150ml skimmed milk

### Estimated cost

Estimated cost for nurturing the athlete, including cost for equipment will add up to 20,000 USD

## References

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<http://www.brianmac.co.uk/tplans/sprint.htm>

<http://www.gain-weight-muscle-fast.com/weight-training-programs.html>

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<http://www.nutrition.sg/healthy-balanced-diet.php>