

The 400m Hurdles

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27:1/2; 9-24, 2012

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Introduction

This article aims to provide a summary drawn from the current literature of the main aspects of the 400m hurdles as a general guide and a starting point for further study.

Like the high (or short) hurdles sprint, intermediate (or long) hurdling is a rhythmic sprinting event. Speed and speed endurance are basic requirements, but the ability to express these in a rhythmic pattern is more important. The fact that 400m hurdlers must be especially aware of the stride pattern between hurdles requires them to be highly concentrated throughout the race. Although beginners tend to view the hurdles as barriers and consider jumping over them rather than running over them, hurdling is not a jumping event. Thus, the first lesson to learn is that clearing a hurdle takes only an elongated sprinting stride, with as little deviation as possible from correct sprinting (LINDEMAN, 1995; WINKLER, 1989).

The 400m hurdles is arguably the most demanding of all events in the sprints and hurdles group. To be successful, the athlete must be

able to run a fast 400m flat time, possess stamina at distances of 600-800m, possess flexibility and agility, and have a good hurdling technique. From a technical point of view, the 400m hurdler must be able to apply force at take-off to move through the hurdle and minimise deceleration. Application of the right kind of forces at take-off ultimately determines the efficiency of one's hurdling skills. The 400m hurdler must determine the number of strides to use between the hurdles, and then master that stride pattern. He or she must be able to maintain a consistent rhythm for 10 hurdles. The hurdlers who will be the best in the long are those who have the special strength and consistent technique to run over 10 hurdles with the least amount of technical decrement from start to finish. 400m hurdlers must also learn to hurdle with either lead leg, although a left lead leg is recommended because it allows the hurdler to run on the inside of the lane on both curves. The ability to hurdle with either leg is a safety valve if the chosen stride pattern does not work and it allows the hurdler to change the stride pattern during a race due to the weather, track surface, lane assignment, or poor hurdle clearance. (JOLLY, 1989; LINDEMAN, 1995; MCFARLANE, 1980; WINCKLER, 2000; on external effects in the 400m hurdles race see: QUINN, 2010).

As in all track events longer than 200m, race distribution is very important, and a specific plan should be developed. One plan is to take the athlete's best time over 200m flat and add 2.5 sec, giving a target time for the initial 200m of the race; the second 200m time of the race is the target time plus 3.0 sec. This formula gives the athlete a good beginning guideline. In general, knowledge and experience of racing over

400m flat builds a solid foundation of race management skills, which can be carried over to the hurdles event (JOLLY, 1989; WINCKLER, 2000).

The distance, the spacing, and the heights of the hurdles are the only aspects of the race that remain constant. For both men and women, the distance from the start to the first hurdle is 45m, with 35m between the hurdles and 40m from the final hurdle to the finish. The height of the hurdles differ, though: 91.44cm for men and 76.20cm for women (JOLLY, 1989; MCFARLANE, 1980).

According to WINCKLER (2000), when selecting potential 400m hurdlers, coaches should look for:

- Sprint ability;
- Aggressive mental attitude and concentration;
- Competitive nature;
- Strength and strength endurance;
- Dynamic mobility within the hips.

History and Progression

The intermediate hurdle race has a relatively short history. The first record of such a race being run was at Oxford University in 1860, with each competitor going over 12 hurdles. However the race did not appear on the programme of major meets on a regular basis until well after the turn of the 20th century. The event gained most of its popularity in France and appeared in the Olympics for the first time in Paris in 1900. In that race the hurdles consisted of 30-foot-long poles and there was a water jump between the last hurdle and the finish line. Walter Tewksbury of the United States won in 57.6 sec, to the disappointment of the French who had developed the race and had it placed on the Olympic programme. It is interesting that Tewksbury also won the 200m race, was second in the 100m race and third in the 200m hurdles.

The 440 yard intermediate hurdles gained popularity slowly in the United States. The event was not included in the NCAA Championships except in Olympic years until 1959, and it was not until 1963 that the intermediate hurdles replaced the 220 yard low hurdles in college track meets.

In spite of this lack of emphasis, Americans have dominated the event in world competition since its beginning. The mid-1950s saw the rise of three great intermediate hurdlers, Glenn Davis and Eddie Southern of the United States and Gert Potgieter of South Africa. Davis and Southern duelled frequently and were the first competitors to break 50 seconds in 1956 when Davis beat Southern at the United States Olympic trials.

At the 1968 Olympic Games in Mexico City, the finals of the 400m hurdles was one of the most spectacular hurdle races in history. The spread of winning times of the four heats was less than one second. The fastest heat was won by Ron Whitney (USA) in a record time of 49.0 sec and the slowest heat was won by Roberto Frinolli (ITA) in 49.9 sec. However, in the semifinals Frinolli ran 49.2 sec and Gerhardt Hennige (FRG) ran 49.1 sec. Thus all of the eight finalists had run 49.6 sec or better in the preliminary races. When the final race was over, David Hemery (GBR) was the new Olympic champion and the world record holder with a remarkable time of 48.1 sec.

After 1968 Ralph Mann (USA) and Wayne Collett (USA) became the top intermediate hurdlers. They duelled each other regularly from their high school days in various hurdle races and their rivalry came to a climax in the NCAA finals in 1970 when Mann edged Collett at the tape and set a new world record for the 440 yard distance with a time of 48.8 sec, Collett in 49.2 sec also breaking the existing record.

In the 1972 Olympic Games John Akii-Bua (UGA) won the race in a remarkable world record time of 47.8 sec ahead of Mann. The seventies and eighties were dominated by Edwin Moses (USA), who won Olympic gold medals in 1976 and 1984 (plus a bronze medal in 1988) and world championships in 1983 and 1987. Moses won 122 consecutive 400m or 440 yard hurdles races from 1977 to 1987 and set four world records, bringing the world standard down to 47.02 sec). The current men's world record holder is also an American, Kevin Young who ran 46.78 sec in winning the 1992 Olympic Games.

The first documented 400m hurdles race for women took place in 1971. The IAAF officially recognised the event in 1974 and the first official world record of 56.51 sec was set by Krystyna Kacperczyk (POL). A special world championships for the event was held in 1980 and won by Bärbel Broschat (GDR) in 54.55 sec. The event was included in the programme of the 1983

IAAF World Championships in Athletics and for the first time in the Olympic Games in 1984. The current women's world record of 52.34 sec by Yuliya Pechonkina (RUS) was set in 2003. Over the years, many athletic commentators and officials have brought up the idea of lifting the height of the women's 400m hurdles to incorporate a greater requirement of hurdling skill.

Table 1a: 400m hurdles world record progression - men

Time	Athlete	Date	Location
55.0	Charles Bacon (USA)	July 22, 1908	London
54.0	Frank Loomis (USA)	August 16, 1920	Antwerp
53.8	Sten Pettersson (SWE)	October 4, 1925	Paris
52.6y	John Gibson (USA)	July 2, 1927	Lincoln
52.0	Morgan Taylor (USA)	July 4, 1928	Philadelphia
51.9	Glenn Hardin (USA)	August 1, 1932	Los Angeles
51.8	Glenn Hardin (USA)	June 30, 1934	Milwaukee
50.6	Glenn Hardin (USA)	July 26, 1934	Stockholm
50.4	Yuriy Lituyev (USSR)	September 20, 1953	Budapest
49.5	Glenn Davis (USA)	June 29, 1956	Los Angeles
49.2	Glenn Davis (USA)	August 6, 1958	Budapest
49.2	Salvatore Morale (ITA)	September 14, 1962	Belgrade
49.1	Rex Cawley (USA)	September 13, 1964	Los Angeles
48.8	Geoff Vanderstock (USA)	September 11, 1968	Echo Summit
48.1	David Hemery (GBR)	October 15, 1968	Ciudad de México
47.82	John Akii-Bua (UGA)	September 2, 1972	Munich
47.64	Edwin Moses (USA)	July 25, 1976	Montreal
47.45	Edwin Moses (USA)	June 11, 1977	Westwood, Los Angeles
47.13	Edwin Moses (USA)	July 3, 1980	Milan
47.02	Edwin Moses (USA)	August 31, 1983	Koblenz
46.78	Kevin Young (USA)	August 6, 1992	Barcelona

Table 1b: 400m hurdles world record progression - women

56.51	Krystyna Kacperczyk (POL)	July 13, 1974	Augsburg
55.74	Tatyana Storosheva (URS)	June 26, 1977	Chemnitz
55.63	Karin Roßley (GDR)	August 13, 1977	Helsinki
55.44	Krystyna Kacperczyk (POL)	August 18, 1978	Berlin
55.31	Tatyana Zelenzova (URS)	August 19, 1978	Podolsk
54.89	Tatyana Zelenzova (URS)	September 2, 1978	Prague
54.78	Marina Makeyeva (URS)	July 27, 1979	Moscow
54.28	Karin Roßley (GDR)	May 17, 1980	Jena
54.02	Anna Ambraziené (URS)	June 11, 1983	Moscow
53.58	Margarita Ponomaryova (URS)	June 22, 1984	Kiev
53.55	Sabine Busch (GDR)	September 22, 1985	Berlin
53.32	Marina Stepanova (URS)	August 30, 1986	Stuttgart
52.94	Marina Stepanova (URS)	September 19, 1986	Tashkent
52.74	Sally Gunnell (GBR)	August 19, 1993	Stuttgart
52.61	Kim Batten (USA)	August 11, 1995	Gothenburg
52.34	Yuliya Pechonkina (RUS)	August 8, 2003	Tula

Mechanical Aspects

Hurdling, whether in the high or intermediate hurdles, is a sprinting action. In fact, if the velocities achieved in the two races are evaluated, it turns out that the long hurdler is actually sprinting at a faster mean velocity than the 110m hurdler. For example, Kevin Young, in his 46.78 WR had an average velocity of 8.55 m/sec where as Colin Jackson, in his 12.91 WR had an average velocity of 8.51 m/sec.

The hurdler should strive to accelerate the last few strides into the hurdle. The last stride prior to the hurdle should be shorter and quicker than the previous strides. The final strides of the approach should be characterised by an erect posture with tall hips. As in high hurdling, a quick lead knee action initiates the take-off to the hurdle. Leading with the knee is the single most important fundamental of efficient hurdling technique. A quick lead knee results in

Since the parabolic path of the hurdler's center of mass has not deviated from normal sprinting action as much as the high hurdler's, the intermediate hurdler does not need to be as aggressive in trying to "snap" the lead leg down, nor does he need to snap the trunk back, since he has not leaned into the hurdle as much as the high hurdler would. Complete recovery of the trail leg, continuing the knee drive forward and upward after it has passed the hurdle, ensures an active landing of the lead leg and continuation of efficient sprinting.

The hurdle clearance stride is a good indicator of the efficiency of hurdle clearance. A comparison of the hurdle clearance strides of "elite", "average", and "poor" male hurdlers shows that shorter clearance strides with a higher percentage of the stride in front of the hurdle correlate to higher level performance (see table below).

	H. clear. str.	Dist. before H.	Dist. beyond H.	% before H.	% beyond H.
"Elite" Hurdler	3.50m	2.22m	1.28m	63.5%	36.5%
"Average" Hurdler	4.02m	2.44m	1.58m	60.6%	39.4%
"Poor" Hurdler	4.54m	2.65m	1.89m	58.4%	41.6%

what is often called a delayed trail leg, that is, the trail leg gets full extension at take-off.

The lower hurdle height requires less body lean into the hurdle than in the high hurdles. Although the trail leg may clear the hurdle in a lower plane than in the highs, it must continue driving forward and upward to allow the hurdler to return to good sprinting action.

The stride length for the hurdler who takes 13 strides between hurdles averages 2.45m versus an average stride length of 2.05m for the high hurdler. The hurdle clearance stride for the intermediate hurdler is approximately 3.50m, and is about the same for the high hurdler. Of course, since the hurdle is about 15cm (women: about 8cm) lower than in the highs, the hurdler does not need to raise his or her center of mass as high as the high hurdler to clear the hurdle.

The hurdler should swing back an extended lead arm in opposition to the trail leg to maintain balance over the hurdle. He or she should not "drive" or "snap" the elbow back, as this shortens the moment of inertia of the arm (relative to the trail leg) and creates rotation imbalances.

Rotation problems are also caused by reaching too far with the lead arm and are magnified on the curve in the long hurdle race. The trail arm (on the side of the lead leg) should deviate as little as possible from normal sprinting action (LINDEMAN, 1995).

Like in the short hurdles, the goal of every intermediate-hurdles coach should be to teach hurdlers how to clear the hurdles efficiently so that they return to the ground quickly in near-sprinting form. To achieve this goal, the follow-

ing seven fundamentals of hurdling mechanics presented by WINCKLER (1998) for high hurdlers should be applied to 400m hurdlers, too:

1. The center of gravity is raised only as high as is necessary to clear the hurdle.
2. Flat sprint speed can be increased by increasing the stride length or rate. Hurdling speed can be increased only by improving the efficiency of the hurdle stride (not necessarily increasing its length) and of the stride rate between the hurdles.
3. The take-off angle is determined by the horizontal velocity and the vertical velocity. The latter raises the centre of mass; tall hurdlers have an advantage in already having a higher centre of mass.
4. Trunk lean should be enough to maintain sprint form.
5. The action of the trail leg and the lead arm are in parallel planes. Improper arm action causes compensating actions that result in an off-balance landing.
6. The lead leg has a short moment of inertia, leading with the knee.
7. Head position consists of keeping the eyes up and focused on the next hurdle.

Technical Aspects

Start to the first hurdle

The 400m hurdler uses a normal sprint start. The placement of the feet in the blocks depends on the choice of lead leg and the number of strides to the first hurdle (JOLLY, 1989).

400m hurdlers should attack the first four to five strides with the characteristic inclination of the body found in the normal acceleration from blocks. The acceleration pattern over the first 30m of the race is not unlike that of a 400m sprinter. By the 30m mark the hurdler should be focused on the initial hurdle and make any slight adjustments that might be necessary (LINDEMAN, 1995; MCFARLANE, 1980). The hurdle should be attacked from about 10m away. This will ensure an aggressive run, which will minimise the deceleration that normally occurs at this point. The hurdlers should also minimise height and increase speed over

the hurdle by “sprinting through the hurdle” (WINCKLER, 2000).

The acceleration and stride pattern to the first hurdle are of vital importance as they establish the hurdler’s rhythm through the first few hurdles (LINDEMAN, 1995). While men normally use a stride pattern of 20-23 strides, women typically use 22-25 strides. The number of strides to the first hurdle is predicated by the athlete’s speed and strength and by which lead leg they prefer to use at the first hurdle. Most hurdlers will use the left leg for hurdles on the curve, as this allows them to run on the inside of the lane without fear of pulling the trail leg over the inside of the hurdle during clearance. A right-leg lead on the curve must allow for the trail leg to clear the hurdle without being off to the inside of the lane, as this results in disqualification. An athlete who uses the right leg lead on the curve should run toward the middle to outside portion of the lane to allow space for the trail leg to clear over the hurdle. This also means that the athlete will run farther than he or she were on the inside of the lane (WINCKLER, 2000).

According to JOLLY (1989), the common recommendation for men is 22 strides because it closely resembles the rhythm of a 15-stride pattern between the hurdles. When an even number of strides is used to the first hurdle, the runner places the lead leg in the rear block. For an odd number of strides, the lead leg starts in the front block (LINDEMAN, 1995).

While a 20-stride approach requires the hurdler to shorten or “chop” strides to get an effective 13-stride pattern to the second hurdle, the resultant stride length from a 21-strides approach to the first hurdle leads most efficiently to an effective stride pattern of 13 strides between hurdles. A 22-stride approach to the first hurdle results in a slightly shorter stride length between hurdles, which may lead to the hurdler elongating or reaching to get an effective 13-stride pattern between the first two hurdles. A 23-stride approach to the first hurdle will most often result in a 15-strides pattern between hurdles (LINDEMAN, 1995).

The speed and rhythm to the first hurdle is slightly slower than in the flat 400m race, due to the more controlled stride pattern demanded by hurdling. If any stride adjustment is required, it should be made in the middle of the approach. The last four to six strides before the hurdle should be very consistent and involve an acceleration (JOLLY, 1989).

Hurdle technique

JOLLY (1989) holds that the opinion that hurdle technique is not important is one of the most serious misconceptions about 400m hurdling. Good 400m hurdle technique allows the athlete to negotiate the hurdle with minimum deviation from normal running technique.

Departure and action over the hurdle

The placement of the take-off foot, i. e., the foot of the trail leg, to the track should be active (i.e., pulling backward from the hip with the foot in dorsiflexion and the ankle joint strong and stable). Active landing means an active, quick placing of the trail leg into the take-off position somewhat faster than in the previous running stride. This active landing action will “cut” or shorten the last stride, preventing planting or braking action and minimizing loss of velocity going into the hurdle. This placement should be on the forefoot and occurs approximately 2m from the hurdle (WINCKLER, 2000).

Going into the hurdle, the hurdler must lead with the knee of the lead leg, because by doing so the most efficient body position for attacking the hurdle is provided. To achieve this leading with the knee, the lower part of the lead leg should be flexed quickly, heel to the buttocks, as soon as possible after the lead leg has broken contact with the ground. The lower part of the lead leg remains tucked under the thigh until the thigh has reached parallel to the ground or above. When the thigh reaches its apex, momentum is then transferred to the lower leg by relaxing the hamstring and allowing the knee joint to open. The knee does not lock. It is not a mistake to not fully straighten the lead leg at the knee joint. This lower leg position allows for quicker, more efficient rotation of the upper portion of the lead leg with less effort (JOLLY, 1989; WINCKLER, 2000).

The action of the lead arm is not as pronounced as that of the high hurdler's. The lead leg and its opposing arm must move in a parallel manner, which helps the athlete keep the shoulders and hips square to the hurdle and eliminates the twisting of the upper body. If the arm is directed inward toward the leg, then the leg will also move inward, crossing toward the arm, and the forward motion of the body will be disturbed. The velocity of both arms must coincide with that of the lead leg (JOLLY, 1989; WINCKLER, 2000).

The trail leg must work in concert with the lead-leg and lead-arm actions. The trail leg should be active throughout its range of movement. As the trail foot leaves the ground, the leg is drawn vigorously forward and upward, tucking the heel tightly to the butt and thereby shortening the trail-leg lever as much as possible. This enables the leg to pass over the hurdle with greater speed and reduces the degree of compensating rotation in the rest of the body. The foot of the trail leg should never rise higher than its knee. The trail leg is kept tightly folded until the knee has reached the front of the body and is ready to accelerate downward to the track once again (WINCKLER, 2000).

In clearance, the hurdler should reach the highest point prior to the hurdle, so that the body is on its way down as it crosses the hurdle (JOLLY, 1989).

The hurdle stride is longer than a normal stride, due to the need to elevate the body over the hurdle, but the amount of vertical motion should be kept to a minimum. As shown above, the hurdle-stride length is an excellent overall indicator of the efficiency of hurdle clearance, i. e., the shorter the stride, the more economical the motion (JOLLY, 1989).

MCFARLANE (1980) points out that the hips must be kept “tall” and moving forward throughout the clearance to maintain the running rhythm. If they fall, loss of horizontal speed and an increased number of strides between hurdles will result. Since horizontal speed is less than in the sprint hurdles it seems that

less emphasis is placed on the aggressive attack of the lead leg, running rhythm and hip flexibility. However, neglect here is a mistake.

Touchdown

Since economy of motion and energy is most important in the event, the body motion should be directed forward, with as little side-to-side rotation of the shoulders and arms as possible, as the athlete comes off the hurdle. At touchdown, the athlete's centre of mass should be directly over or slightly ahead of the lead foot. By landing on the toes or ball of the foot, not flatfooted, the athlete will minimise forward braking, or stopping actions and thus will be in a good position for the getaway stride, which is critical in re-establishing the running rhythm between the hurdles. The trail leg is tucked tightly until touchdown. Its action is completed by coming down quickly to a position with the knee once again in sprinting position in front of the body. The getaway stride should be aggressive and grabbing the track. The hurdler should follow the basics of good sprinting, not overstriding or reaching. (JOLLY, 1989; WINCKLER, 1989; WINCKLER, 2000)

Common faults in clearing the hurdle

According to WINCKLER (2000), the following faults seem to be most frequent:

Fault: The take-off is too far from the first hurdle.

Causes: a) The sprint strides during initial acceleration from the blocks are too short. b) The arm action in acceleration to the first hurdle may be too passive.

Corrections: a) The athlete lacks the contractive strength necessary to drive from the blocks with sufficient stride length. b) He or she should lengthen his or her arm action and increase the amplitude of arm movement during the run to the first hurdle and attack the last 10m prior to the hurdle.

Fault: The clearance is too high over the hurdle.

Causes: a) The athlete is too close to the hurdle at take-off. b) The take off foot is planted on the heel too far ahead of the center of mass. c) The take-off is non-existent or non-active. d) The lead leg is not folded tightly until the thigh reaches parallel or above. e) The athlete is afraid of the hurdle.

Corrections: a) The athlete should maintain his or her sprint acceleration posture longer. This keeps the strides shorter and helps the athlete attain higher velocity. The athlete should accelerate in a pattern and not overstride. If the athlete is planting the take-off foot like a long jumper, this will make the last stride before the hurdle too long and result in placement too close to the hurdle. b) A tall posture must be practiced, making the take-off step active and on the front of the foot. c) Again, a tall posture should be practiced. d) Proper lead-leg mechanics and body posture going into hurdle must be rehearsed. What the take-off foot is doing must also be examined. If it is planted on the heel, then the lead leg will tend to open up too soon. e) In practice, hurdles constructed of soft, flexible materials or constructed to be forgiving should be used. If this is the case, the athlete will gain the necessary confidence to run through the hurdle with the velocity necessary to perform efficient technique.

Fault: The athlete hits his or her trail knee on the hurdle.

Cause: Rushing take-off (jumping through the hurdle rather than running off the ground).

Correction: The focus should be on an active take-off step and the force application of the trail leg should not be rushed. Also, the trail leg must be left back until feeling a push-off

of the toe. This will cause a stretch in the thigh muscles that will snap the trail leg through with little or no effort.

Fault: The athlete is off balance coming off the hurdle.

Causes: a) The lead leg and opposite arm are driven inward and not parallel to the direction of travel. b) The trail leg is opening up too soon as it clears the hurdle.

Corrections: a) The athlete should work on keeping lead-leg mechanics as described above to enable him or her to more easily keep actions in line with the direction of the run. Sprint arm action should be used into the hurdle instead of moving the arms across the body. Also, the athlete may be too close to the hurdle. b) A significant amount of work should be done on trail-leg mechanics to keep the leg folded until the thigh has reached a position where the knee is pointing in the direction of travel before opening up toward the ground. This problem often occurs when the athlete is trying to rush the trail leg to the ground.

Fault: The athlete hits hurdles late in the race.

Causes: a) Loss of rhythm. b) Too close to hurdles. c) Loss of concentration.

Corrections: a) The athlete fails to maintain a hips-tall position, which may cause him or her to sit and thereby not maintain good sprint mechanics. b) The athlete should make eye contact with the next hurdle at least 15m away and run aggressively to the hurdle. c) He or she should think of the hurdle race as 400m long and 1.22m wide. He or she should learn to limit attention to what's happening in his or her own lane and to concentrate on his or her own rhythm.

Stride pattern between the hurdles

Success in the 400m hurdles requires a stride pattern that fits smoothly into the 35m between the hurdles. This pattern depends on such factors as the athlete's lead leg, race plan, and natural stride length. A rule of thumb is to use as few strides as possible without overstriding (JOLLY, 1989).

According to JOLLY (1989), the number of strides used from the start to the first hurdle is a good indicator of the stride pattern of the following strides between hurdles. Compatible stride patterns are as follows:

Strides to first hurdle	Strides between hurdles
21	13
21 or 22	14
22	15
22 or 23	16
23 or 24	17

Without question, the ideal stride pattern would be a consistent pattern of an odd number of steps between all hurdles. This odd stride pattern (13s, 15s, 17s, 19s, etc., all the way) allows the hurdler to take all hurdles with the same lead leg (preferably the left), whereas an even stride pattern between hurdles forces the hurdler to alternate his or her lead leg on consecutive hurdles (LINDEMAN, 1995).

However, it is rare for the hurdler to be able to accomplish a consistent number of odd strides all the way through the race. In most cases, the hurdler is forced to make a transition to a greater number of strides between hurdles. A transition takes place when a hurdler changes down to a shorter stride length (because of fatigue, usually around the 5th, 6th, or 7th hurdle, or adverse environmental conditions), which results in one or two more steps between hurdles (JOLLY, 1989; LINDEMAN, 1995).

According to LINDEMAN, there are three forms of transitions: 1) The preferable transition is a single alternate, an example of which would be the left lead-legged hurdler transitioning from 13 to 14 strides, requiring him to then hurdle with a right lead leg over every other hurdle for the

rest of the race. 2) In a dual alternate transition, the hurdler who is leading with his left and taking 13 strides between would take 14 strides and use a right lead leg, then 14 again to get back to the preferred left lead leg, and then finish the race with his left lead leg. 3) The double cut-down is most often used by the inexperienced hurdler who is unable to hurdle with his alternate lead leg. In this case the hurdler who is taking 13 strides between hurdles and leading with his left lead leg would cut down to 15 strides between (so as not having to hurdle with a right lead leg). The disadvantage of this type of transition is that the stride length must be drastically shortened in just a few meters of hurdle clearance from 2.45m to 2.13m. However, very few elite hurdlers ever use a double cut-down transition in a race situation, as their ability to alternate lead legs allows them to use the more effective single or dual alternate transitions. Therefore, the ability to alternate lead legs over consecutive hurdles is the most valuable technique the developing hurdler should be taught.

Regardless of the type of transition which takes place in a race, the long hurdler should have a race plan which dictates for him or her where the transition will take place. This predetermined stride pattern is called the hurdler's effective stride pattern. At the planned transition point in the race, the hurdler should consciously try to increase the stride frequency while reducing the stride length. This change in the stride pattern should be initiated before the hurdler is forced to change due to fatigue (LINDEMAN, 1995).

It is also very important to be able to make any adjustment well in advance of the hurdle, instead of trying to rush an adjustment in the last few strides before the hurdle (LINDEMAN, 1995). As MCFARLANE (1980) points out: "The last three strides before and after clearance must be exact and consistent for every clearance with alterations made between hurdles and not at them."

Hurdling on the curve

To master the turn, the athlete must practice on the turn under both fatigued and non-fatigued conditions and also work in all lanes. If possible, the hurdler should use the left leg

as the lead leg on the turns. When using the right lead leg, the athlete must run more to the centre of the lane to prevent bringing the trail leg outside the hurdle and facing disqualification (JOLLY, 1989).

If the hurdler with a left lead leg is able to run 60cm closer to the inside lane line than the hurdler with the right lead leg for 20 strides (4 for each of the 5 hurdles on the curve), he will gain an entire meter (or 0.12-0.13 sec) on his opponent (LINDEMAN, 1995).

However, it should not be forgotten to mention that many world-class hurdlers have hurdled with a right lead leg. For example, Ralph Mann was a world record-holder in the late 1970s with a right lead leg (LINDEMAN, 1995).

Run-in off last hurdle to the finish line

Hurdle races are often won or lost between the touchdown after the last hurdle and the finish line. At that point, most competitors are fatigued. If in a position to win, the hurdler who first returns to sprint form and attacks the finish line has the best chance of victory (WINCKLER, 1989).

For a fast run-in, the athlete must clear the last hurdle as relaxed, and as technically sound, as possible. At this point, the athlete must concentrate on correct sprinting form and on increasing his or her leg speed to the finish line rather than overstriding (JOLLY, 1989).

A high level of anaerobic endurance that results from including a large volume of speed endurance work in the training programme is the key to a fast run-in from the last hurdle to the finish (LINDEMAN, 1995).

Distribution of Effort

LINDEMAN (1995) points out that the hurdler's distribution of effort throughout the race can be effectively measured by the coach by using a stopwatch to determine the "touchdown times." These times can be charted and reviewed with the hurdler to evaluate his or her race. It's important to note that every hurdler,

from beginner to world-class, loses velocity over the course of the race, as denoted by increasing touchdown times. Major discrepancies in the chart of a race can point to errors in judgment of transitions and late-race adjustments, as well as where fatigue sets in.

The touchdown time at the fourth hurdle in the 400m race is an especially valuable indicator of the distribution of effort during the early stages of the race because it is at the 150m mark or precisely 3/8 of the way through the race. Another good indicator, although more difficult to obtain, is the 200m split. Ideally, the differential in times for the first and second half of the race should be no more than 5%, which is 2.4 sec in a 48 sec effort or 2.5 sec in a 50 sec effort (LINDEMAN, 1995).

Characteristics of Women's 400m Hurdling

According to KERR (1992), the women's 400m hurdle event has major differences to the mens in performance breakdowns. Touchdown times to the first three hurdles appear to be much slower in relation to the rest of the race in comparison to men's performances. It would also appear that for most of the top women 400m hurdlers the second half of the race is dominant, whereas the opposite is true for the men. Further, on examining stride patterns of the leading women hurdlers, speed endurance for the event is still not being developed as well as it could be. There appears to be a large number of women who can maintain 15 strides to hurdle seven but cannot run 15 strides home.

KERR believes that for a female athlete to be internationally successful in the 400m hurdles certain physical characteristics will be required in the future. It appears that the athlete has to be tall with corresponding leg length and physique suitable for the development of the 400m hurdles requirements. The 400m hurdles requires speed, speed endurance, rhythm, strength, reasonable hurdling technique and good emotional control.

Elite female 400m hurdlers should be between 1.70m and 1.80m tall and weigh between 60 and 70kg. They will need to have these physical dimensions for the stride length needed to handle the necessary stride pattern, as well as to develop the physical strength necessary to handle the last 100m of the event. The somatotype is likely to favour mesomorphic/ectomorphic characteristics.

For improvement to occur in the women's 400m hurdles, the athletes are going to have to improve their speed over the first 100m, their stride pattern and their ability to handle fatigue and maintain form and rhythm in the last 100m of the event. It therefore appears that elite female 400m hurdlers should have a sprinting/hurdling/jumping background as a teenager.

The female 400m hurdler should be able to take 22-24 strides to the first hurdle (currently most take 23-25 strides) with a left leg lead and will be looking for a touchdown in the vicinity of 6.3-6.5 sec (currently 6.7-7.0 sec is the norm) to set up a good speed through the first 100m. She is then going to look to running 14 strides to hurdle seven and 15 home. This pattern would enable the hurdler to use left leg leads over the hurdles on the curves and thereby save in distance run and allow for better "attacking" of hurdles on the curves. Obviously, if she is using 14 strides, the hurdler will be capable of hurdling with either leg in the lead position. The athlete is going to be looking for touchdowns in the following ranges:

- 1st hurdle 6.3 to 6.5 sec
- 3rd hurdle 14.6-15.0 sec
- 5th hurdle 23.2-24.0 sec
- 8th hurdle 36.4-37.8 sec
- 10th hurdle 45.4-47.0 sec

This pattern has a different emphasis to that which is practiced by most of the world's leading hurdlers at the moment, with a much quicker first 200m but still maintaining speed over the last 200m to produce faster times (KERR, 1992; see on women's 400m hurdles also: BAILEY, 1987; BREIZER et al., 1985; BREIZER & KORCHEMNY, 1990).

Teaching the 400m Hurdles

According to WARBURTON (1985), one of the most important parts of a 400m hurdler's technical skill is the ability to hurdle confidently with either leg leading over the hurdle, because it enables a smooth transition in stride pattern during the course of a race, thus preventing the unnecessarily fatiguing problem of over or under-striding.

There are a number of ways that alternate leg hurdling can be developed effectively. All of the following hurdling sessions to develop alternate leg hurdling have been found to be beneficial. The measurement between hurdles for each exercise have not been included as coaches will need to experiment to find the correct distance for their own athlete. In warm-up the women's hurdles can be put on the 110m hurdle marks and the men's on about 10m spacings, this allows a relaxed five-stride run between the hurdles for isolating. The height of the hurdle can also be varied from 91.4cm to 1.06m for men and from 76.2cm to 84cm for women.

The various sessions are:

1) One-stride hurdling – using both isolation exercises and full technique runs on both leading legs. This allows rapid repetition and reinforcement of a technique pattern. Up to 10 hurdles in a row is common. The hurdles can be separated as shown in Figure 1 and the athlete runs down the middle with one-stride between hurdles, this gives lead leg at the first hurdle, trail at the second and so on.

2) Two-stride hurdling – this is, according to WARBURTON (1985), an invaluable alternate-leg hurdling session when space is lacking. This involves quick thinking on the behalf of the athlete. To make the session more interesting, as in Figure 2, the hurdles can be moved apart and the athlete will then run down the middle using each leading leg in turn and run down the middle again and use each trailing leg in turn.

3) Three-stride hurdling – this is a common session with timed runs over 3-12 hurdles often used. In this activity, athletes are asked to run

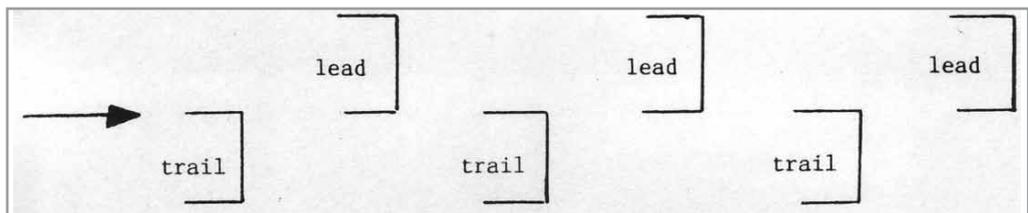


Figure 1: One-stride hurdling variation – isolation exercise

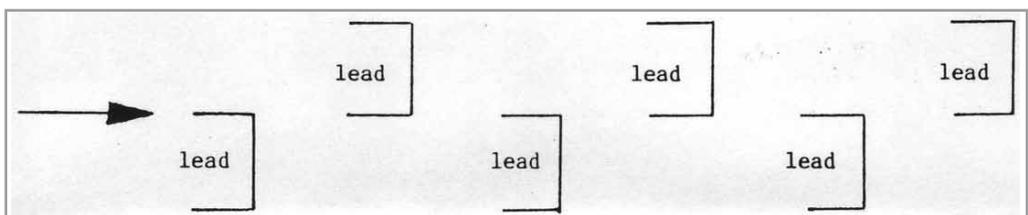


Figure 2: Two-stride hurdling variation – lead or trail leg isolation

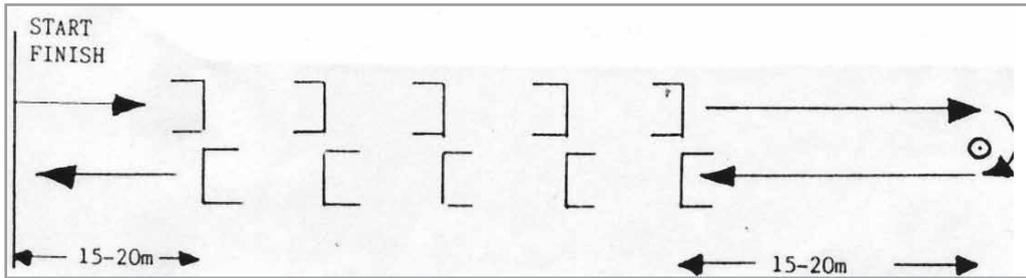


Figure 3: Four-stride Swiss turnabout

first with their left leg lead and then walk back and run with their right leg lead. This encourages equal mental emphasis on each leading leg action. Each run is timed and the coach should be looking for a very low differential between left and right leg lead and between the first and last run of the series.

4) Four-stride hurdling – as with two-stride hurdling but needs more available space. The most common application of this is the Swiss turnabout (Figure 3). The athlete is timed from the start to the finish and recovery is whatever the coach deems to be necessary. Ten runs at this gives one hundred hurdle clearances under progressively more difficult fatigue conditions.

5) Five-stride hurdling – as with three-stride hurdling, but the athlete has more time to concentrate on the hurdling technique. Timed runs over 5-8 hurdles are commonly used, once again looking for a low differential between left and right leg lead.

6) Seven-stride (or double-spaced) hurdling – the hurdles are placed on or near every other sprint hurdle mark, this allows the athlete to develop more speed and develop a more relaxed open rhythm. As with three and live-stride hurdling, the runs can be timed running from the start to the 100m finish. An excellent activity for developing confidence is running at speed over hurdles using either leading leg.

7) The above sessions (3, 4, 5 and 6) can all be carried out on the bend under the same

conditions thus developing an athlete's awareness of hurdling on the bend and his/her spatial awareness needed for a race situation.

8) Six hurdles placed at increasing distances apart – the first space at one-stride, second at two-stride, third at three-stride, etc. up to five-stride spacings. Likewise the spacings could start at three-stride and move up progressively by one-stride to an eight-stride spacing. These activities require a great degree of mental agility on the parts of the athletes. Once agains time the runs from a start line to a finish line.

9) Up to five hurdles over 100m at irregular spacings. Each run is timed and a walk back recovery allowed. On every other run the spacings are altered so that the athlete has to alter the stride pattern used. This session can be varied and the bend used so that there is 100m on the bend from the 200m start and a second 100m down the straight. A short rest is allowed between the first and second 100m stretch with a walk back recovery before the next set of two 100m. This is a fairly relaxed session and gives a comfortable approach to alternate leg hurdling. Concentration by the athlete should be on attack into the hurdle and positive running off and away from the barriers.

10) 200m hurdle spacings – usually 5-6 hurdles with a walk back recovery. The number of repetitions is dependent upon the level of development of the athlete. (See on teaching and coaching the 400m-hurdles also: Bulan-chik, 1983; THOMAS, 1989; VONSTEIN, 1997)

Training Drills

The following technical exercises or drills presented by WINCKLER (2000) serve to correct deficiencies in mechanics, to teach and ingrain proper motor patterns, and to promote local muscle and specific hurdle conditioning. The basis of most hurdling exercises should be sound sprinting exercises. Hurdle training is by nature very specific and training sessions must be geared toward the specific rhythm necessary in hurdling. For advanced hurdlers, special hurdle endurance should be emphasised in training.

High-knee routines (Mach drills)

The exercise is performed with high-knee action, pulling heels to butt. The posture is tall. The ankle joint is kept dorsiflexed and weight bearing is on the forefoot. The progress down the track is slow, with all foot contacts under the centre of mass.

The three high-knee variations are:

- marching,
- skipping,
- running.

Fast-leg routines

This exercise is very difficult and demands good coordination and timing. The objective is to isolate the proper motion of the sprint stride into left- and right-side movements, teaching the proper mechanics of the leg through the recovery cycle. Speed of movement is the ultimate objective, although most athletes will learn this exercise at slow speeds and progress to faster speeds.

The following cues will help with this drill:

- Hips tall.
- Active action with toe-up, heel-up, knee-up sequence.
- Try to place the support foot under the centre of mass at ground contact.
- The recovery leg should cycle, with the ankle passing above the knee of the support leg.

The two types of fast-leg routines are:

1) Single-side actions – From a jog the athlete attains a tall posture. In concert with the arms, one leg is quickly cycled through the recovery cycle, following the sequence of actions described above and accelerating the foot back to the track again. Performance of the movement is alternated with two to three jogging steps. When performed properly, the athlete senses an acceleration upon each contact of the foot with the track. Emphasis should be on the following:

- full and proper range of motion,
- acceleration of the thigh and heel upward during recovery,
- acceleration of the thigh downward in preparation for support,
- active cycling culminating in a clawing action of the foot in preparation for contact with the ground again,
- the lower leg is kept folded tightly to the thigh until full thigh lift is complete,
- quick actions of the hands and arms in proper sprint arm motions.

2) Dual-side actions – The dual-side form of the fast-leg routine is performed in the same way as the single-side form, except the movement alternates from left side to right side following the two to three jogging steps between movements. When athletes become accomplished with this exercise, they can accelerate quickly and perform its actions at near top speed. The ultimate objective is to improve speed of movement, neuromuscular timing, and coordination, and thus be able to perform an efficient movement on each and every stride in full-flight sprinting.

Fence drill for trail leg

The hurdle (about 76cm high) is placed about 61cm from a fence or other immovable object and parallel to it so that the athlete is facing the fence and the hurdle in the normal orientation. Standing on the side of the hurdle, the athlete inclines his or her body toward the fence and puts one or both hands on the

fence. The athlete then performs the trail-leg action over the side of the hurdle. The exercise develops specific dynamic mobility as well as teaches correct mechanics of the trail leg. This is more of a beginner's exercise, but it may be useful to more advanced athletes as well. The action should be quick, and the trail leg should never be allowed to open up at the knee once it has cleared the hurdle. The action coming off of the hurdle should be an acceleration of the thigh toward the ground.

Partner drill for trail leg

This exercise is performed similarly to the "fence drill for trail leg", except the hurdle is placed on the track and the athlete uses a partner in place of the fence. The partner actively pulls the athlete by the hand as the athlete performs the trail-leg movement. In this way the athlete feels what it is like to move quickly over the hurdle and can begin coordinating a fast, uninterrupted movement of the trail leg with good horizontal velocity over the hurdle.

- The trail foot should be kept tight to the butt and the knee should move forward and upward.
- The thigh lift should continue until the trail foot has once again come in alignment under the thigh.
- The trail-leg thigh should be accelerated downward with the foot under the center of mass.
- The hips should move through the hurdle, and the athlete should feel the fast horizontal displacement of his or her hips forward. The hips should be maintained in tall position throughout.

Fast-leg lead leg over hurdles

In this exercise the fast-leg action is performed with the lead leg over the side of four to six hurdles spaced at 7-8.5m apart for three-stride rhythm and 9-11.5m apart for five-stride rhythm. The hurdle height used can vary from 30.5 to 76cm.

This drill can be performed:

- with a normal stride pattern and heel recovery between hurdles,
- using a fast-leg action on every lift of the lead leg, thus placing more emphasis on local muscular endurance.

The hips should be maintained in tall body posture throughout, and the principles prescribed earlier for fast-leg routines should also be adhered to.

Running hurdle skills

Usually 3-5 hurdles are used, with spacings of 7.5-8.2m and heights of about 68.5-76cm. The exercises are individually oriented in the sense that each may be used to emphasise very different technical points. The speed of the run is usually quite fast because the primary objective is to increase one's ability to perform correct technical or mechanical movements at high velocity.

The two variations of this exercise are:

1) Half-hurdle lead leg

On each run the emphasis may differ:

- Maintaining distance of the take-off foot from the hurdle.
- Active take-off step going into hurdle.
- Heel of lead leg to butt going into hurdle.
- Fast-leg action of the lead leg.
- Active downward action of the lead leg coming off the hurdle.
- Performance of lead-leg action while accelerating over five hurdles.

2) Half-hurdle trail leg

On each run the emphasis may differ:

- Draw the heel to the butt actively and as soon as the take-off foot leaves ground.
- Keep the trail leg continuously in motion from the start of movement until touch-down.
- Keep the trail toe up and the leg folded until completion of action to the front of the body.
- Perform the lead-leg action on the outside

of the hurdle. This aids in keeping balance and in being able to perform the trail-leg and associated arm actions in a coordinated fashion.

- Actively accelerate the trail leg to the ground under the center of mass and in position to sprint into next stride.
- Imagine that the lead leg and trail leg are racing each other to the ground. This encourages quick action off of the hurdle and helps anticipate the touchdown.

Sample Workouts

The following sample workouts are also taken from WINCKLER (2000).

Autumn Preparation

Monday	Circuit training (field circuit: such as 30 push-ups, 10 tuck jumps, 100m run, 30 lunges, 40 crunches, 200m run, 10 pull-ups, plus other exercises, including medicine balls and jump ropes. The circuit is performed with 0-30 sec rest between stations and should last 15 min per circuit.)
Tuesday	Bounding, core training (long alternate-leg bounding on grass: 8 x 60m. Core: push-ups, sit-ups, and so on for the trunk.)
Wednesday	Hill running (2 x 4 x 200-250m hill, with walk back recovery)
Thursday	Sprint development, hurdle skill (rollover starts, i. e., start by leaning over until you lose your balance forward and go; high-knee running; butt kicks; fast-leg exercise; marching and skipping over hurdles; runs over 4 hurdles set at about 68.5cm and spaced at 20m: 6-8 runs)
Friday:	Acceleration, circuit training (rollover starts; block starts over 2 hurdles; circuit work as on Monday)
Saturday	Aerobic running (tempo runs over 100-200m with 50m walk between; continuous run at varied pace for 15 min)
Sunday	Rest

Indoor Preparation

Monday	Sprint development, power development
Tuesday	Hurdle skill, weights, multi-jumps
Wednesday	Hill running, strength endurance
Thursday	Weights, core training, swimming
Friday	Acceleration, lactacid power
Saturday	Tempo running, core training
Sunday	Rest

Indoor Season

Monday	Sprint development, power development
Tuesday	Hurdle skill, weights
Wednesday	Lactacid power, strength endurance
Thursday	Weights, core training, swimming
Friday	Acceleration
Saturday	Competition
Sunday	Rest

Outdoor Preparation/Season

Monday	Hurdle skill, weights, core training
Tuesday	Lactacid power, 400m hurdle distribution
Wednesday	Core training, tempo running
Thursday	400m hurdle starts, weights
Friday	Core training, tempo running
Saturday	Competition
Sunday	Rest

Further Information

Valuable 400m hurdles training advice can also be found in: BOYD, 2011; BROWN, 1992; ISKRA, 1999 and ISKRA, 2007.

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