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THE EFFECT OF LATERAL FOOT PLACEMENT RELATIVE TO HIP WIDTH ON THE SPRINT START FOR WOMEN

by

Roberta Ann Howells

A Dissertation Submitted to
the Faculty of the Graduate School at
The University of North Carolina at Greensboro
in Partial Fulfillment
of the Requirements for the Degree
Doctor of Education

Greensboro
1972

Approved by

Rosemary McGee
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APPROVAL PAGE

This dissertation has been approved by the following committee of the Faculty of the Graduate School at The University of North Carolina at Greensboro.

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April 10, 1972
Date of Examination

HOWELLS, ROBERTA ANN. The Effect of Lateral Foot Placement Relative to Hip Width on the Sprint Start for Women. (1972) Directed by: Dr. Rosemary McGee. Pp. 73.

It was the purpose of this study to investigate the effect of lateral foot placement relative to hip width on the sprint start for women. The three lateral foot placements, narrow, medium and wide, were determined relative to each subject's trochanter width. The narrow lateral foot placement was determined by setting the malleoli apart a distance equal to twenty-five percent less than trochanter width. The medium lateral foot placement was determined by aligning the malleoli with the trochanters in a vertical plane. The wide lateral foot placement was determined by setting the malleoli apart a distance equal to twenty-five percent greater than the trochanter width. It was hypothesized that: (1) there would be no difference in the time elapsed from a starting point to a 5-yard distance using three different lateral foot placements, (2) there would be no difference in the time elapsed from a starting point to a 25-yard distance using three different lateral foot placements, (3) there would be no difference in the time elapsed from a starting point to a 50-yard distance using three different lateral foot placements, (4) there would be no difference in the order in which the sprints were run, (5) there would be no difference because of hip width classification from each of the three lateral foot placements at the 5-yard, 25-yard and 50-yard marks.

Sixteen high school female track athletes participated in a series of nine training sessions and one testing session. Each subject ran six 50-yard sprints, two from each lateral foot placement. The times for the two sprints from each of the three lateral foot placements were averaged and considered as the subject's score.

The data were collected by using three electric time clocks connected to three photoelectric systems placed at distances 5-yards, 25-yards and 50-yards from the starting line. The clocks were activated by a switch when the subject removed her foot from the back starting block. The clocks were stopped when the subject ran past the photoelectric systems breaking the light beams.

The data were statistically analyzed by analysis of variance. The level of confidence was set at .05.

Null hypothesis one, that there would be no difference between three lateral foot placements at a 5-yard distance was accepted. Null hypothesis two, that there would be no difference between three lateral foot placements at a 25-yard distance was accepted. Null hypothesis three, that there would be no difference between three lateral foot placements at a 50-yard distance was rejected. The use of the narrow and medium lateral foot placements resulted in faster time elapsed than the use of the wide lateral foot placement. Null hypothesis four, that there would be no difference in the order of trials run was rejected. The mean time for trial one was significantly

faster than the mean time for trial six at the 50-yard mark. Null hypothesis five, that there would be no difference because of hip width classification from each of the three lateral foot placements at the 5-yard, 25-yard and 50-yard marks was rejected. The subjects classified as having wide hip widths seemed to have an advantage in time elapsed over the subjects classified as having either narrow or medium hip widths.

ACKNOWLEDGMENTS

The writer wishes to express appreciation to her adviser, Dr. Rosemary McGee and to her committee consisting of Dr. Lois Edinger, Dr. Gail Hennis and Dr. Frank Pleasants for their help and encouragement. Sincere appreciation is also extended to Mr. Thomas Howells and Mr. William Kahl for their help with the experimental apparatus. The writer wishes to thank the track coaches and the students who served as subjects.

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CHAPTER I

INTRODUCTION

Many track coaches agree that a good start is an essential factor in winning sprint races. As early as 1888 Michael Murphy suggested the crouch start position to C. H. Shirrill, a competitor in the Rockaway Hunt Club games (28). Since that time much research has been conducted regarding the effectiveness of a variety of sprint starting positions. The research in this area has concentrated primarily on longitudinal foot spacing, hip elevation, reaction time to the starting gun and placement of the front foot behind the starting line.

In general, track and field experts agree on three standard starting positions: the bunch, the medium and the elongated. Cretzmeyer and others describe these positions:

> In bunch spacing, the sprinter, while in a standing position, places the toe of the back foot opposite the heel of the front foot.
>
> In medium spacing, the sprinter, while in the on-your-mark position, places the knee of the back leg opposite the ball of the front foot.
>
> In elongated spacing, the sprinter, upon assuming the on-your-mark position, places the knee of the back leg opposite the heel of the front foot. (7: 38)

These standard starting positions take into consideration individual anatomical differences in regard to foot length and lower leg length, but neglect to consider lateral foot placement with regard for hip width. Research concerning the effectiveness of lateral foot placement on sprint starting times is extremely limited; yet lateral foot placement relative to hip width may be an important factor in the sprint start.

Many researchers (32), (34), (35), (39), (44), (45), (46), (47), (50), (53), (55) have investigated aspects of the sprint start. The results of these investigations have contributed to the area of knowledge designed to understand factors inherent in man's ability to move rapidly. Most of the researchers have utilized close approximations of the three standard starting positions. These positions were studied for their relative effectiveness on force exerted (35), (38) and velocity gained (29), (44), (45). Other researchers, utilizing the standard starting positions, studied the effect of independent variables on starting times (39), (47), (50), (53).

Statement of the problem. The purpose of this study was to investigate the effectiveness of lateral foot placement relative to hip width on the medium sprint start for trained women sprinters.

To aid in the solution of the major problem it was necessary to determine (1) the effect of lateral foot placement on starting time, (2) the effect of lateral foot placement on sprinting time, (3) the effect of the order in which the trials were run and (4) the effect of hip width on starting times and sprinting times using three lateral foot placements.

The .05 level of significance was set to test the following null hypotheses:

1. There is no difference in the time elapsed from a starting point to a 5-yard distance using three different lateral foot placements.

2. There is no difference in the time elapsed from a starting point to a 25-yard distance using three different lateral foot placements.

3. There is no difference in the time elapsed from a starting point to a 50-yard distance using three different lateral foot placements.

4. There is no difference in the order in which the sprints were run. For example, the subjects' first sprints will not yield faster times than the second or third, etc. sprints.

5. There is no difference because of hip width classification from each of the three lateral foot placements at the 5-yard, 25-yard and 50-yard marks.

The study should help physical educators and track coaches understand better the effect, if any, of the individual anatomical difference of hip width relative to lateral foot placement on starting and sprinting times.

Limitations of the study. This study had the following limitations:

1. The subjects were members of high school varsity female track teams.

2. Starting time was limited to a 5-yard distance. This distance was measured from the starting line to a point five yards down the track.

3. Sprinting times were limited to a 25-yard and a 50-yard distance. These distances were measured from the starting line to a point twenty-five and fifty yards down the track.

4. The training period was limited to nine sessions, approximately thirty minutes each.

5. The testing period was limited to one session consisting of six 50-yard sprints for each subject.

6. Lateral foot placement was limited to three positions. The positions were (a) equal to trochanter width, (b) twenty-five percent greater than trochanter width and (c) twenty-five percent less than trochanter width.

7. The starting position used was the medium start.

8. Reaction time was not considered as a factor.

9. Hip width classification was limited to three categories: narrow, medium and wide. The narrow category included all subjects whose hip width measured below -1 standard deviation from the mean hip width. The medium category included all subjects whose hip widths measured ±1 standard deviation from the mean hip width. The wide category included all subjects whose hip widths measured above +1 standard deviation from the mean hip width.

Definition of terms. The following definitions were accepted for the purpose of this study.

1. Medium starting position. The medium starting position is the longitudinal foot spacing assumed by each subject. While in a kneeling or on-your-mark position, the knee of the back foot is placed opposite the distal end of the longitudinal arch of the front foot.

2. Lateral foot placement. Lateral foot placement is defined as the distance the outer malleoli are set apart in a lateral direction. Three lateral foot placement positions are specific to this study.

(a) Narrow placement -- placement of the feet laterally so that the outer malleoli are set at a distance twenty-five percent less than the trochanter width.

(b) Medium placement -- placement of the feet laterally so that the outer malleoli and the trochanters are aligned in a vertical plane.

(c) Wide placement -- placement of the feet laterally so that the outer malleoli are set at a distance twenty-five percent greater than the trochanter width.

3. Starting time. Starting time is defined as the time elapsed from the removal of the back foot from the starting block to the crossing of a line five yards beyond the starting line in a forward direction down the track.

4. Sprinting time. Sprinting time is defined as the time elapsed from the removal of the back foot from the starting block to the crossing of lines twenty-five and fifty yards respectively beyond the starting line in a forward direction down the track.

5. Hip width. Hip width is the measured distance between the greater trochanters. Each subject's hip width measurement was classified into one of three categories: narrow, below -1 standard deviation; medium, $\pm$1 standard deviation; wide, above $+$1 standard deviation.

6. Trained female track athlete. Trained female track athlete is defined as a high school woman track athlete having one or more years of high school track experience and having undergone the nine training sessions specific to this study. See Appendix A, page 62.

7. On-your-mark. On-your-mark is the first position assumed by a runner prior to the start of a race. The

runner is in a kneeling position with both feet touching the starting blocks, one knee touching the track and both hands placed close to the starting line.

8. Get set. Get set is the last position assumed by a runner prior to the start of a race. The runner's feet are firmly pressing against the starting blocks, the hips are elevated and the hands are helping to support the body weight at a point close to the starting line.

CHAPTER II

REVIEW OF LITERATURE

> Proper starting is probably the most controversial problem in track. It would be safe to say that there are as many proper starts as there are athletes with different anatomical measurements and physiological reactions. It can be generalized that the best starting position is one that permits you to complete your race in the shortest possible time (16: 18).

Researchers have been interested in experimenting with techniques of the track start. Most research has utilized male subjects and has dealt with various sprint starting positions, reaction time to the gun, sequence of movement and force exerted against the starting blocks. An attempt has been made to review only those articles pertinent to this study. The areas considered were the starting blocks, longitudinal foot spacing, hip elevation, starting and sprinting times and lateral foot placement.

Starting blocks. During the early years of track and field competition, sprinters prepared for a race by digging small holes in the track. Their toes and the balls of their feet were placed in the holes in an attempt to overcome inertia at the start of a race. In 1927, George Bresnahan, track coach at the State University of Iowa, invented a device known as starting blocks which offered an angled surface for the runner's feet. By nailing the starting blocks to the track a comfortable

distance apart, the runner obtained the added advantage of an above-the-track angled surface on which to place his feet. Bresnahan believed the added advantage of exerting force on the starting blocks would lower a sprinter's starting time.

Hayden and Walker (34) attempted to investigate the question of starting blocks scientifically. They compared the time spent by a runner in reaching a point seven and one-half feet from a starting line using starting blocks and using holes in the track. The starting blocks allowed a faster start with an average distance advantage of one foot.

Longitudinal foot spacing. Conflicting evidence has been reported concerning the superiority of any one longitudinal foot spacing. With the aid of force blocks, designed to measure foot pounds of pressure, Kistler (38) studied the thrust exerted by the starter against starting blocks. Based on 300 starts from three different foot spacings made by thirty trained sprinters, he found that the total foot-pounds of pressure exerted by both feet was greatest for an elongated or 26-inch longitudinal foot spread. A 21-inch foot spread yielded the next highest and a 16-inch spread resulted in the least amount of pressure exerted.

It would seem that the advantage of the greater force exerted would yield faster starting times. Dickinson (29) investigated the time taken to run a 2.5-yard distance from three different longitudinal foot placements. He found that the bunch start of 10.5-inch foot spread yielded the fastest times, the 21-inch spread slower times and the 26-inch spread the slowest times. In this study, the shorter foot spacing proved to be advantageous in running a 2.5-yard distance.

In 1952 Henry (35) studied force-time characteristics of the sprint start. Eighteen sprinters ran four, 50-yard sprints, one from each of four longitudinal foot spacings. The foot spacings were defined as 11-inch, 16-inch, 21-inch and 26-inch. Running times were recorded at 5-yard, 10-yard and 50-yard distances from the starting line. Henry concluded that the medium stance offered a worthwhile advantage to the sprinter. The runners consistently made their best times using a medium, 16-inch or 21-inch, longitudinal stance and their poorest times using the 11-inch bunch stance. This advantage was evident at the 10-yard and 50-yard marks.

Hip elevation. Trained sprinters tend to raise their hips five to twenty-five degrees higher than their shoulders while in a set position (7). Observation of this natural tendency led White (50) to investigate the effect of hip elevation on starting time. Three different hip elevations

were measured from the bunch starting position: a sprinter's natural position, lower than normal and higher than normal. Starting time was defined as the interval which elapsed between the pistol shot and the breaking of contact with the back foot. From the data obtained on twenty-four trained sprinters, White concluded that a higher than normal hip position yielded significantly faster times.

Stock (47) compared three standard starting positions with a high hip position in which the back knee was equal to or greater than 165 degrees. The data were collected at distances of twenty yards and fifty yards from the starting line. The bunch and high hip starting positions accounted for the fastest times at the 20-yard mark and the high hip position accounted for the fastest time at the 50-yard mark.

Since hip elevation can be determined by the angle of the knee, some writers have described starting positions in terms of knee angles. Doherty (30) described knee angle for 20-inch longitudinal foot spacing as close to 100 degrees for the back knee and close to eighty-five degrees for the front knee. Cureton (8) studied the mechanics involved in the leg lift. He concluded that a 102 degree angle at the knee joint produced the strongest upward thrust. Pugh and Watts (18) described foot spacing as ranging between fourteen and twenty inches for most

girls with a front knee angle of ninety degrees and a rear knee angle between 110 and 120 degrees.

Starting times and sprinting times. Sills and Pennybaker (46) investigated the velocities of nine college sprinters at 5-yard intervals up to thirty-five yards with the aid of microswitches attached to strings stretched across the track. They concluded that no increase in velocity occurred beyond a 30-yard distance. All of the subjects attained their maximum velocities between the 15-yard and 30-yard marks.

The effect of sprinting velocities on three different foot spacings was studied by Sills and Carter (45). The foot spacings included the bunch spacing, a preferred spacing and the medium spacing. Nine varsity sprinters served as subjects. The findings indicated that the subjects attained their maximum velocities between the 20-yard and 25-yard marks. In addition, they concluded that the type of foot spacing which yielded the fastest starting time for each sprinter also yielded the fastest sprinting time.

Researchers interested in measuring starting times have defined starting time in a number of ways. Starting times have been measured as the time elapsed from the pistol shot to the breaking of contact of the back block (50) and from the starting line to distances of two and

five tenths yards (29), five yards (45), (46), (53), seven yards (24) and ten yards (35), (44).

Sprinting time also has been measured at different distances. Distances ranging from twenty yards to fifty yards were found to be the most commonly used indicators of sprinting times (35), (38), (44), (45), (46), (47).

Lateral foot spacing. One study was found relative to lateral foot spacing. Using a 16-inch medium stance, Hulstrand (53) attempted to determine the effects of three lateral foot positions relative to pelvic width on thirteen experienced female sprinters and twenty-four inexperienced female subjects. The experienced sprinters were enrolled in a college track and field class. The inexperienced subjects never participated in track and field training. The three lateral foot positions consisted of a 9-inch narrow placement, a medium placement in which the outer malleoli were vertically aligned with the trochanters and a wide placement which was the difference between nine inches and the medium placement added to the medium placement. A 15-inch front starting block was used for the adjustment of the feet laterally. A microswitch set within the rear starting block activated a time clock the moment the subject released her foot from the rear block. The clock was stopped when the subject broke a string which was stretched across the track and connected to a timer at a 5-yard distance from

the starting line. Each subject made six 5-yard runs from each of the three lateral foot positions. The average of the last five runs was considered the subject's score. No significant differences were found among the three lateral foot positions for either the experienced or the inexperienced subjects.

Hulstrand also classified the subjects into three hip width groups: narrow, 11.5 inches to 12.2 inches; medium, 12.3 inches to 12.6 inches and wide, 12.7 inches to 13.4 inches. The data were analyzed by analysis of variance in an attempt to determine whether differences occurred among the three lateral foot positions for each of the three specific hip width groups. Hulstrand concluded that no one lateral foot position was superior to any other for each of the three hip width groups for either the experienced or inexperienced subjects.

Summary. A considerable amount of research has been reported on various aspects of the sprint start. Although the investigations have resulted in a better understanding of the component parts of the skill, research findings do not conclusively support any one sprint starting position as superior to any of the others studied.

Research shows that the use of starting blocks seems to offer a runner a decided advantage in short sprint races. However, the exact placement of the blocks on the track has been extremely controversial.

Investigations into foot spacing have yielded no substantial evidence in favor of any longitudinal stance. Limited information regarding the lateral spacing of the feet was found in one study. The study indicated that the lateral spacing of the feet was not a factor in times recorded in a 5-yard run.

Distances ranging from two and five-tenths feet to ten yards have been considered indicative of starting time. Distances ranging from twenty yards to fifty yards were the most common indicators of sprinting times.

Research has begun to reveal some pertinent facts regarding the sprint start for men. More information, specific to female runners, is needed for a better understanding of the track start for women.

CHAPTER III

PROCEDURES

A. Pilot Study

A pilot study was undertaken in the spring of 1971 in which two female track team members enrolled at Grimsley High School, Greensboro, North Carolina, served as subjects. A description of the subjects, the starting blocks, the training sessions, individual starting positions, the testing session and the data analysis follows.

Subjects. The subjects were sixteen years of age and attending their Sophomore year of high school. Both subjects had been members of the girls' track team and had previous sprinting experience. Subject number One weighed 100 pounds; was 5 feet, 1 inch tall; had a hip width measurement of 11.7 inches and a leg length measurement of 30 inches. Subject number Two weighed 122 pounds; was 5 feet, 6 inches tall; had a hip width measurement of 12.5 inches and a leg length measurement of 32 inches.

Starting blocks. Specially designed starting blocks were constructed for use in the pilot study. The back block measured four inches in width and was adjustable in a forward and backward direction. The front block measured fifteen inches in width and was attached to a

center rail connecting both blocks. Both blocks had a foot surface angle of forty-five degrees. The blocks were secured to the track surface by means of three six-inch nails. An illustration of the blocks can be seen in Figure 1, page 18.

Training session. The subjects underwent a series of ten sessions; nine training and one testing. The objective of the training sessions was to allow the subjects to become familiar with a medium track starting position in which three lateral foot placements, relative to hip width, were used.

The writer developed specific procedures to be followed during the nine training sessions. The procedures were based on track literature, personal experience and coaches' opinions. Each session was evaluated for its effectiveness and appropriateness. The evaluation consisted of the writer's subjective judgment regarding the length of time taken to complete each activity each session, the effectiveness of the equipment and the responses of the subjects to the sprints. Improvements were made in the original plan and incorporated into a final revision. A copy of this revision may be found in Appendix A, page 62.

The order of execution of the three lateral foot placements for each session was determined by a random

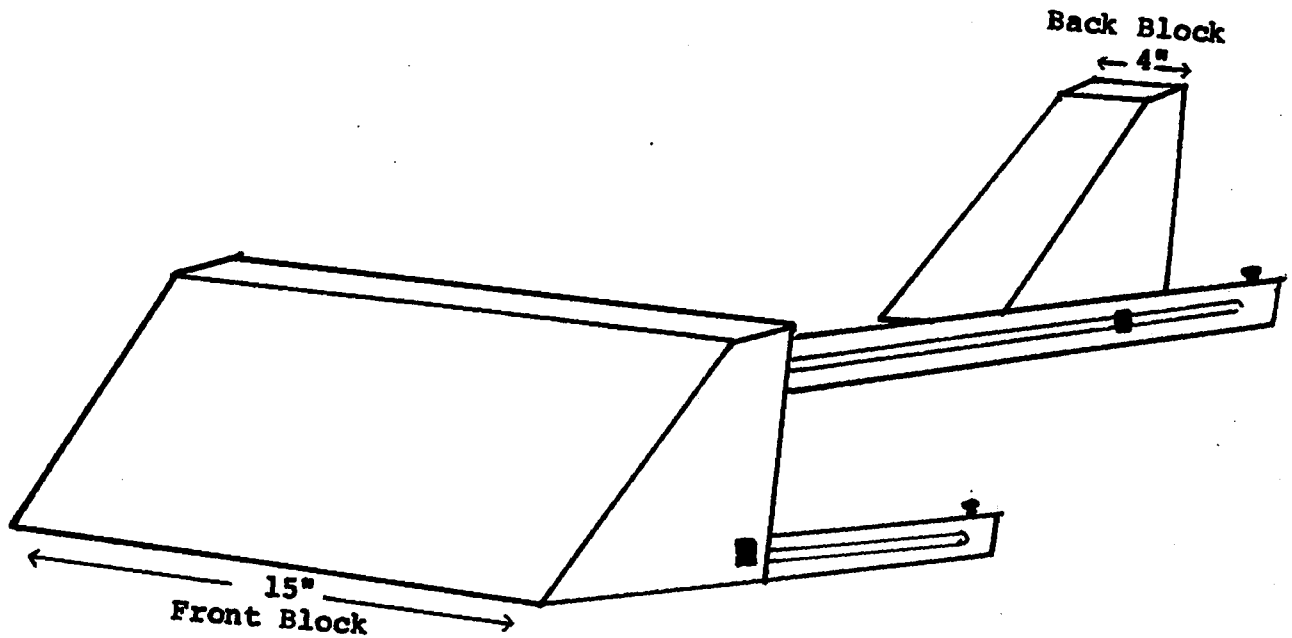


Figure 1.
Starting Blocks

selection of the total possible combinations. There were six total possible ways to combine the three lateral foot placements: wide, narrow, medium; narrow, wide, medium; medium, narrow, wide; wide, medium, narrow; narrow, medium, wide and medium, wide, narrow. Each of the six possible combinations was written on a separate piece of paper and drawn from a hat one at a time by the writer. The first combination drawn became the order of execution of the three lateral foot placements for the first training session. The second combination drawn became the order of execution for the second training session, etc. This procedure was followed until all six combinations were drawn determining the lateral foot placements for training sessions one through six. To determine the order of execution of the three lateral foot placements for training sessions seven through nine, the six possible combinations were again placed in a hat. The first combination drawn by the writer determined the lateral foot placement for training session seven, the second for training session eight and the third for training session nine.

Individual starting positions. Each subject's hip width measurement was taken at the level of the trochanters with an anthropometric calipher. Lateral foot placement was then determined for each subject by calculating twenty-five percent greater than and less than the hip width

measurement. A twenty-five percent deviation from trochanter width was chosen on the basis of the need for a specific percentage deviation for all subjects, consideration for a wide stance which was not exaggerated to the point of discomfort and consideration for a narrow stance which would allow the feet to spread laterally in close approximation of most commercially sold starting blocks. The front starting block was marked with colored tape corresponding to each subject's calculated narrow, medium and wide lateral foot placements. This was done to enable the outer malleoli to be set apart the specified lateral distance.

Longitudinal foot placement for the medium starting position was determined by the measured distance between the toe of the back foot and the distal end of the longitudinal arch of the front foot while the subject assumed a kneeling or on-your-mark position. The adjustable portion of the rail connecting the front and back block was marked with colored tape. This marking enabled the back block to be set a specified longitudinal distance from the front block for each subject.

The subject's hands were placed at a comfortable distance from the front block. This distance was measured, recorded and kept constant each session for each subject.

Hip elevation was kept constant by fixing the angle of the knees at 102 degrees and 90 degrees for the back

leg and front leg respectively. This was accomplished by placing a 10-inch piece of cardboard, cut at the designated angle, posterior on the leg at the level of the knee. When the subject's hips were elevated to the correct height, the 10-inch cardboard fit firmly into the angle formed by the knee joint.

Testing session. Each subject ran six 50-yard sprints, two from each of the three lateral foot placements. The sprinting order of the three lateral foot placements for each subject for the six trials was determined by the Latin Square method of rotation. Each one of the three lateral foot placements was written on two separate pieces of paper. These six pieces of paper were drawn from a hat one at a time by the writer. The result of the drawing was medium lateral foot placement, medium lateral foot placement, wide lateral foot placement, narrow lateral foot placement, wide lateral foot placement and narrow lateral foot placement. This became the starting point for the order of rotation in which each subject placed her feet on the starting blocks for the six trials. For example, the first subject's lateral foot placement for the six trials was medium, medium, wide, narrow, wide and narrow (the order drawn from the hat). The second subject's lateral foot placement for the six trials was in the following order: medium, wide, narrow, wide, narrow and medium. The order simply rotated.

The times for the two runs from each lateral foot placement at the 5-yard, 25-yard and 50-yard mark were then averaged. An example follows: subject number One ran two sprints from the narrow lateral foot placement. The two times recorded at the 5-yard mark were averaged. The average of these two times was considered the starting time from the narrow foot placement. A similar procedure followed to determine times at the 25-yard mark and at the 50-yard mark.

The data were recorded by an electrical timing device at the 5-yard mark and manually operated stop watches at the 25-yard and 50-yard marks. The electrical timing device consisted of a Lafayette timer accurate to 1/100 of a second, a photoelectric cell, a photoelectric cell control box, an electrical extension cord and a starting switch attached to the back starting block.

The apparatus operated in the following way: when the subject removed her foot from the back starting block, a switch was released closing the electrical circuit and activating the photoelectric cell and the Lafayette timer. When the subject passed the 5-yard mark, an attendant deactivated the photoelectric cell causing the timer to stop. The time indicated on the face of the timer was recorded as the starting time. An attendant was necessary to deactivate the photoelectric cell due to difficulties encountered with the sensitivity of the cells to the

sunlight. The element of human error was then a factor present in the 5-yard starting time.

Four manually operated stop watches were used to obtain sprinting times. Two watches were located at the 25-yard mark and two were located at the 50-yard mark. Twenty-five yard sprinting time for each lateral foot placement was recorded as the average of the times shown on the two stop watches for two trials. Fifty-yard sprinting time was recorded in the same manner.

Data analysis. Mean scores were calculated for the three lateral foot placements at the 5-yard, 25-yard and 50-yard marks. Table I, page 24, shows the mean times for the three lateral foot placements at the three specified distances.

At the 5-yard distance, the wide lateral foot placement mean time of 1.21 seconds was the fastest mean time. The narrow lateral foot placement mean time of 1.22 seconds was the next fastest mean time and the medium foot placement mean time of 1.32 seconds was the slowest of all.

At the 25-yard distance, the narrow foot placement yielded the fastest mean time of 4.25 seconds. The wide foot placement yielded the next fastest mean time of 4.32 seconds, and the medium foot placement the slowest mean time of 4.38 seconds.

TABLE I

MEAN TIMES FOR TWO SUBJECTS FROM THREE LATERAL FOOT PLACEMENTS AT 5, 25, AND 50 YARDS*

Foot Placement	5-Yard Time	25-Yard Time	50-Yard Time
Narrow	1.22**	4.25	7.60
Medium	1.32**	4.38	7.70
Wide	1.21	4.32	7.69

*Times shown in seconds
**One trial only for subject number One.

At the 50-yard distance, the narrow lateral foot placement mean time of 7.60 seconds proved to be the fastest. The wide lateral foot placement mean time of 7.69 seconds was next fastest, and the medium lateral foot placement mean time of 7.70 seconds was the slowest.

Table II, page 26, shows the mean starting and sprinting times for the six trials in consecutive order. The data indicated that the subjects' first trial at the 5-yard distance, regardless of foot placement, yielded the fastest mean time of 1.22 seconds and the last trial yielded the second fastest mean time of 1.24 seconds. Mean times at the 25-yard and 50-yard mark were fastest on the last trial. These times were 4.20 seconds for twenty-five yards and 7.38 seconds for fifty yards. The first trial mean times of 4.25 seconds and 7.50 seconds for twenty-five and fifty yards respectively represented the second fastest mean times. The first and last trials yielded either the fastest or second fastest times at all three distances.

Discussion. No attempt was made to statistically apply analysis of variance to these limited preliminary data. The wide lateral foot placement seemed to yield the fastest mean starting time. The advantage gained at the 5-yard mark, however, seemed lost at the 25-yard and at the 50-yard mark. The narrow lateral foot placement appeared to yield the fastest mean sprinting times

TABLE II

MEAN STARTING AND SPRINTING TIMES FOR THE SIX TRIALS*
N=2

Yards	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
5	1.22	1.28**	1.25	1.26**	1.34	1.24
25	4.25	4.32	4.40	4.38	4.35	4.20
50	7.50	7.68	7.75	7.98	7.75	7.38

*Times shown in seconds
**One trial time only for subject number One

at both the 25-yard and 50-yard marks. The medium lateral foot placement seemed to yield the slowest mean times at all three distances.

When lateral foot placement was disregarded and only the times from the various trials were considered, the first and last trials yielded either the fastest or second fastest times at all three distances.

The pilot study proved to be advantageous to the writer primarily for information gained during the training and testing sessions. A workable plan for the nine training sessions was developed and much information was acquired regarding the testing apparatus. A switch for starting the timing device was perfected. Problems which occurred with the Lafayette photoelectric cells led to a search for a solid state photoelectrical system with a wider range.

B. The Study

In the fall of 1971, sixteen female track athletes from high schools in Western Connecticut served as subjects for the study. All subjects participated in a series of ten sessions: nine training and one testing. A description of the procedures used in the study regarding the subjects, the training sessions, individual starting positions and the testing session follows.

Subjects. Sixteen female, high school track athletes ranging in age from 15.4 years to 17.8 years served as subjects for the experiment. Specific information regarding each subject may be found in Appendix B, Table IX, page 68. The subjects were members of high school track teams and had had previous sprinting experience. Their average weight was 116.3 pounds; their average height measured 5 feet 5 inches; their average hip width measured 12.3 inches and their average leg length was 33.3 inches. Two subjects were enrolled at Danbury High School, Danbury, Connecticut; six subjects were enrolled at Newtown High School, Newtown, Connecticut and eight subjects were enrolled at Wilton High School, Wilton, Connecticut.

Training sessions. The subjects participated in a series of nine training sessions. An example of a typical session follows. The subjects jogged 200 yards and followed this with a series of stretching exercises. They then spiked their starting blocks to the track and began the sprints. Each subject helped another assume a correct starting position. For this particular session the sprinter concentrated on a relaxed head position and a low angle of body lean on the first few steps. The order of execution of the runs specific to this session was medium lateral foot placement, wide lateral foot placement and narrow lateral foot placement, which meant that the subjects ran

their first sprint from the medium lateral foot placement, their second sprint from the wide lateral foot placement and their third sprint from the narrow lateral foot placement, etc. in that order of execution. The following distances were run: ten yards, one from each lateral foot placement; fifteen yards, two from each lateral foot placement; twenty-five yards, two from each lateral foot placement and fifty yards, one from each lateral foot placement. A description of the specific procedures followed during each of the training sessions may be found in Appendix A, page 62.

Since the subjects were located in three different schools, the writer traveled to each school for each series of sessions. The subjects at Newtown High School participated in the first series of sessions, the subjects at Wilton High School participated in the second series of sessions and the subjects at Danbury High School participated in the third series of sessions.

The subjects were met immediately after their regular school day. This allowed the time of day for each session to be held constant. The sessions were held daily Monday through Friday except for inclement weather in which case the sessions were postponed until the following day. All sessions were held on standard cinder tracks.

Individual starting positions. Hip width measurement, toe to toe measurement and hands to front foot measurement

were taken to determine each subject's starting position. The procedure was the same as used in the pilot study and described in detail on page 19.

Testing session. The tenth session consisted of testing. Each subject ran six 50-yard sprints; two from each of the three lateral foot placements. The sprinting order was determined by the Latin square method of rotation. This procedure was described in detail on page 21. The times recorded for each subject at the 5-yard, 25-yard and 50-yard marks for the two runs for each lateral foot placement were averaged. The averages of these two runs from each lateral foot placement were considered as the subjects' 5-yard time, 25-yard time and 50-yard time. This procedure was the same as that used in the pilot study and described on page 22.

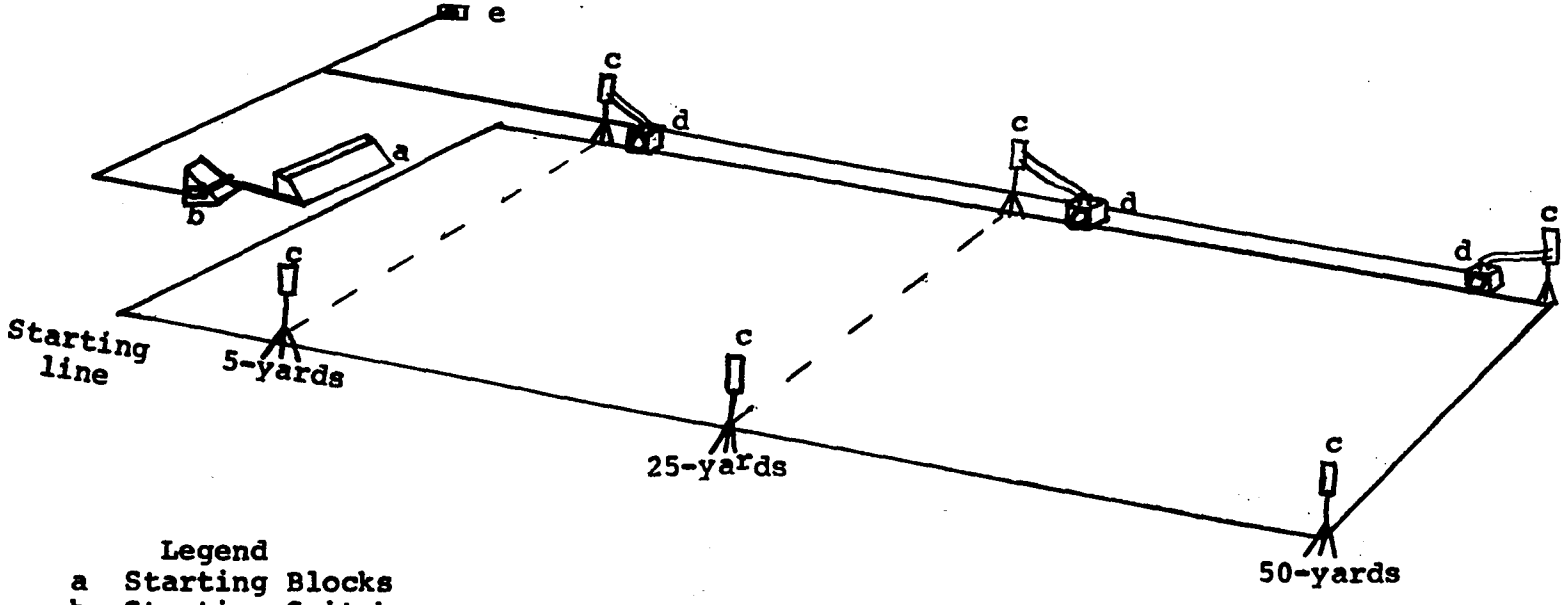
The first testing session took place at Newtown High School on October 1, 1971; the second testing session took place at Wilton High School on October 19, 1971 and the third testing session took place at Danbury High School on November 5, 1971.

The equipment used consisted of three model #54014 Lafayette timers accurate to 1/100 of a second, three model #1600-3R Arrowhead Photoelectric Systems, starting blocks, electrical extension cords and a starting switch. Each photoelectric system and timer was identified and was

placed at the 5-yard, 25-yard and 50-yard marks each of the three testing sessions.

A diagram of the testing area can be seen in Figure 2, page 32. Fifty yards of sprinting area was measured on a straight stretch of track. The starting line and points down the track 5-yards, 25-yards and 50-yards from the starting line were marked. A Lafayette timer connected to an Arrowhead photoelectric system was placed at each of the three points on the track. The photoelectric systems were mounted on wooden standards 33.3 inches from the ground; the height of the subjects' average leg lengths. A plumb line was dropped from the photoelectric cell to the track to align the light beam with the corresponding yardage.

The starting blocks were placed on the track in accordance with each subject's individual starting position. In a set position the subject's back foot depressed a bar connected to the starting switch opening the electrical circuit. When the subject removed her foot from the back starting block, the starting switch was released closing the electrical circuit and activating the three time clocks located at the 5-yard, 25-yard and 50-yard marks. As the subject ran past each of the 5-yard, 25-yard and 50-yard marks, light beams within the battery powered photoelectric systems were broken causing the time clocks to stop. The data recorded were the times showing on the time clocks. An attendant reset the



Legend

a Starting Blocks
b Starting Switch
c Photoelectric System
d Time Clock
e Source of Electricity

Figure 2

View of Testing Area

time clocks and the photoelectric systems after each subject completed a trial and the data were recorded.

CHAPTER IV

ANALYSIS OF THE DATA

Sixteen female high school track athletes participated in nine training sessions and one testing session. Each subject ran six 50-yard sprints, two from each of three lateral foot placements, during the testing session. The time elapsed from the starting line to the 5-yard, 25-yard and 50-yard marks was recorded by means of electrical time clocks connected to photoelectric systems. The two sprints for each subject from each lateral foot placement were averaged. The average of the two sprints was considered the subject's score.

The data collected were tested statistically by analysis of variance in an attempt to determine the effect, if any, of three different lateral foot placements relative to hip width on starting time and sprinting time; the difference, if any, in the order of trials run and the effect, if any, of three hip width classifications on lateral foot placement.

The .05 level of significance was set to test the following null hypotheses:

1. There is no difference in the time elapsed from a starting point to a 5-yard distance using three different

lateral foot placements.

2. There is no difference in the time elapsed from a starting point to a 25-yard distance using three different lateral foot placements.

3. There is no difference in the time elapsed from a starting point to a 50-yard distance using three different lateral foot placements.

4. There is no difference in the order in which the sprints were run. For example, the subjects' first sprints will not yield faster times than the second or third, etc. sprints at the 5-yard, 25-yard and 50-yard marks.

5. There is no difference because of hip width classification from each of the three lateral foot placements at the 5-yard, 25-yard and 50-yard marks.

Lateral foot placements. Table III, page 36, shows the mean time elapsed and the standard deviation for three lateral foot placements at three different distances. The means and standard deviations at the 5-yard distance were .99 seconds and .054 seconds respectively for the narrow lateral foot placement, .994 seconds and .10 seconds respectively for the medium lateral foot placement and .996 seconds and .084 seconds respectively for the wide lateral foot placement.

At the 25-yard distance the mean and standard deviation for the narrow lateral foot placement were 3.883

TABLE III

MEAN TIME ELAPSED AND STANDARD DEVIATIONS FOR THREE LATERAL FOOT PLACEMENTS AT THE 5-YARD, 25-YARD AND 50-YARD MARKS*
N=16

Distance	Narrow Placement		Medium Placement		Wide Placement	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
5-Yard	.99	.054	.994	.10	.996	.084
25-Yard	3.883	.154	3.878	.174	3.951	.286
50-Yard	7.027	.289	7.004	.344	7.127	.40

*Time in seconds

seconds and .154 seconds, for the medium lateral foot placement the mean and standard were 3.878 seconds and .174 seconds and for the wide lateral foot placement the mean and standard deviation were 3.951 seconds and .286 seconds.

At the 50-yard distance the narrow lateral foot placement yielded a mean of 7.027 seconds and a standard deviation of .289 seconds, the medium lateral foot placement a mean of 7.004 seconds and a standard deviation of .344 seconds and the wide lateral foot placement a mean of 7.127 seconds and a standard deviation of .40 seconds.

Table IV, page 38, shows a summary of the analysis of variance for three lateral foot placements at the 5-yard, 25-yard and 50-yard marks. The variance between the three lateral foot placements at the 5-yard and 25-yard marks yielded F ratios of .0637 and 2.54 respectively. These F ratios were not significant at the .05 level of confidence. However, at the 50-yard mark, the variance between the three lateral foot placements yielded an F ratio of 5.061 which was significant at the .05 confidence level.

The data indicated that at the 5-yard and 25-yard marks no differences occurred in the amount of time elapsed between the narrow, medium or wide lateral foot placements. Hypothesis number one stating that there is no difference in the time elapsed from a starting point to a 5-yard distance using three different lateral foot placements was accepted. Hypothesis number two stating that there is no

TABLE IV

ANALYSIS OF VARIANCE FOR THREE LATERAL FOOT PLACEMENTS AT THE 5-YARD, 25-YARD AND 50-YARD MARKS
N=16

Yards	Source	Sum of Squares	df	Mean Square	F
5	Between Variables	.000329	2	.000164	.0637
5	Between Subjects	.242895	15	.016193	6.293 *
5	Interaction	.077199	30	.002573	
25	Between Variables	.0529	2	.02645	2.54
25	Between Subjects	1.8556	15	.123706	11.88 *
25	Interaction	.3124	30	.010413	
50	Between Variables	.1360	2	.068	5.061 *
50	Between Subjects	5.3594	15	.357293	26.592 *
50	Interaction	.4031	30	.013436	

*Significant at the .05 level of confidence

difference in the time elapsed from a starting point to a 25-yard distance using three different lateral foot placements was accepted.

At the 50-yard mark, the data indicated that a significant difference occurred between the variables. A subsequent investigation using the Scheffe' (13) test revealed that these differences occurred between the means of the wide lateral foot placement and the narrow lateral foot placement, .10 seconds, and between the means of the wide lateral foot placement and the medium lateral foot placement, .123 seconds. The S value was .10. In both cases the wide lateral foot placement yielded significantly slower times at the 50-yard mark. Hypothesis number three stating that there is no difference in the time elapsed from a starting point to a 50-yard distance using three different lateral foot placements was rejected.

The advantage gained by beginning the race from either the narrow or medium lateral foot placement was evident only at the 50-yard mark. Since this advantage did not manifest itself at the 5-yard or 25-yard marks, a number of contributing factors may have helped to produce these results. In the writer's opinion, the position of the feet on the starting blocks for both the narrow and medium lateral foot placements may have contributed to the exertion of greater foot-pounds of pressure against the

starting blocks, and may have contributed to the subjects' reaching their most efficient strides sooner. It also may be possible that the subjects reached their maximum acceleration rates beyond the 25-yard mark. Although 5-yard starting time and 25-yard sprinting time were not significantly different for the three lateral foot placements, the possible advantages of exerting greater force against the starting blocks, falling into an efficient running stride sooner and reaching maximum acceleration beyond twenty-five yards may have been important factors contributing to the results. It seems evident that additional studies are needed to remove these factors from the condition of mere conjecture.

The F ratios between the subjects of 6.293, 11.88 and 26.592 at the 5-yard, 25-yard and 50-yard marks respectively were significant at the .05 level of confidence. This indicated that differences in sprinting ability existed between the subjects. Some subjects were significantly faster sprinters than other subjects.

Order of Trials. Scores for all subjects were arranged by trials in an attempt to determine whether differences occurred in the order in which the sprints were run. All of the subjects' first trial scores, second trial scores, etc. were listed in order. Means and standard deviations were calculated for each trial. The data were statistically analyzed by a trial-by-subject analysis of variance.

Table V, page 42, shows the subjects' mean times elapsed and the standard deviations for each of the six trials at a 5-yard, 25-yard and 50-yard distance. At the 5-yard mark, the means ranged from .976 seconds for trial five to 1.021 seconds for trial two, a difference of .045 seconds. At the 25-yard mark, the means ranged from 3.869 seconds for trial one to 3.969 seconds for trial four, a difference of .1 second. At the 50-yard mark the means ranged from 6.973 seconds for trial one to 7.178 seconds for trial six, representing a difference of .205 seconds.

Table VI, page 43, shows the analysis of variance for the six trials at the 5-yard, 25-yard and 50-yard marks. The between trials F ratios of .933 and 1.162 at the 5-yard and 25-yard marks respectively did not reach the previously set level of significance. The between trials F ratio of 2.966 at the 50-yard mark, however, was significant at the .05 confidence level. The F ratios between the subjects of 7.066, 10.786 and 21.774 at the 5-yard, 25-yard and 50-yard marks respectively were all significant at the .05 confidence level, indicating differences existed between the subjects' elapsed times. That is, some subjects were faster sprinters than other subjects at each of the three marked distances.

The between trials F ratio of 2.966 at the 50-yard distance reached the .05 level of confidence. However, a subsequent investigation by the Scheffe' (13) test revealed

TABLE V

MEAN TIME ELAPSED AND STANDARD DEVIATIONS FOR SIX TRIALS AT THE 5-YARD, 25-YARD AND 50-YARD MARKS*
N=16

Yards	Trial 1		Trial 2		Trial 3		Trial 4		Trial 5		Trial 6	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
5	.989	.07	1.021	.141	.995	.088	.979	.095	.976	.075	1.00	.062
25	3.869	.185	3.872	.172	3.881	.193	3.969	.406	3.894	.203	3.939	.180
50	6.973	.355	6.985	.319	7.021	.339	7.106	.427	7.053	.418	7.178	.353

*Time in seconds

TABLE VI

ANALYSIS OF VARIANCE FOR SIX TRIALS AT THE 5-YARD, 25-YARD AND 50-YARD MARKS
N=16

Yards	Source	Sums of Squares	df	Mean Square	F
5	Between Trials	.0214	5	.0042	.933
5	Between Subjects	.4783	15	.0318	7.066*
5	Interaction	.3433	75	.0045	
25	Between Trials	.1332	5	.0266	1.162
25	Between Subjects	3.7058	15	.2470	10.786*
25	Interaction	1.7184	75	.0229	
50	Between Trials	.4868	5	.0973	2.966*
50	Between Subjects	10.7143	15	.7142	21.774*
50	Interaction	2.4654	75	.0328	

*Significant at the .05 confidence level

that a significant difference between the trial means did not occur. One would have to assume that the significant difference was between the trials with the greatest mean difference. In this case between trials one and six. Consequently, at the 5-yard and 25-yard marks, there were no differences in time elapsed between the trials. However, at the 50-yard mark, there was a difference in time elapsed between trial one and trial six. Trial one yielded a faster mean time than trial six.

When running multiple 50-yard sprints within a relatively short period of time, a difference in time elapsed between the trials occurred only at a 50-yard distance. The subjects performed better on the first trial than on the last trial. As a group, the subjects demonstrated that a 50-yard "all-out" effort after recovery could be sprinted five consecutive times without a significant change in performance. A decrease in performance, however, was shown at the 50-yard mark when the subjects sprinted their sixth trial.

Hip width classification. The subjects were classified according to their trochanter widths in an attempt to determine whether there was a difference in time elapsed because of hip width classification. The subjects' mean trochanter width was 12.36 inches with a standard deviation of .746 inches. All subjects whose trochanter widths measured between plus and minus one standard deviation were classified as having medium hip widths. Plus and minus one standard deviation was chosen in an attempt to more closely

approximate the normal curve. Normally the greater number of subjects would fall plus and minus one standard deviation from the mean. There were ten subjects representing 62 percent of the total group whose trochanter widths measured between 11.61 inches and 13.11 inches. All subjects whose trochanter widths measured below minus one standard deviation were classified as having narrow hip widths. Three subjects representing 19 percent of the total group had trochanter widths measuring less than 11.61 inches. All subjects whose trochanter widths measured above plus one standard deviation were classified as having wide hip widths. Three subjects representing 19 percent of the total group had trochanter widths measuring more than 13.11 inches.

These data were tested statistically by means of the Kruskal-Wallis (20) H test to determine differences, if any, in hip width classification for each lateral foot placement at the 5-yard, 25-yard and 50-yard marks. The Mann-Whitney (20) test for U was then used to determine where differences, revealed by the H test, occurred.

Table VII, page 46, shows the values of H for three hip width classifications for each lateral foot placement at the 5-yard, 25-yard and 50-yard marks. At the 5-yard mark, the H of 6.358 indicated that a difference in time occurred between the three hip width classifications when all

TABLE VII

H VALUES FOR THREE HIP WIDTH CLASSIFICATIONS FOR EACH LATERAL FOOT PLACEMENT AT THE 5-YARD, 25-YARD AND 50-YARD MARKS
N=16

Distance	Narrow Lateral Foot Placement	Medium Lateral Foot Placement	Wide Lateral Foot Placement
5-Yards	3.705	4.673	6.358*
25-Yards	6.752*	8.105*	5.922
50-Yards	7.570*	8.793*	6.465*

*Significant at the .05 level of confidence for 2 df.

NOTE: See TABLE XII, APPENDIX B, to examine the means.

subjects began their sprints from a wide lateral foot placement. At the 25-yard mark, the H values of 6.752 and 8.105 indicated a difference in time between the three hip width classifications from the narrow and medium lateral foot placements. At the 50-yard mark, the significant H values of 7.570 for the narrow lateral foot placement, 8.793 for the medium lateral foot placement and 6.465 for the wide lateral foot placement indicated that a difference in time occurred between the three hip width classifications at all three lateral foot placements.

The Mann-Whitney (20) test for U was utilized to determine where the differences, indicated by the significant H values, occurred. Therefore, the hip width groups were compared by using the U statistic only when the H values were significant. Refer to Table VII, page 46.

Table VIII, page 48, shows the values of U resulting from the comparisons of each hip width classification to each other. At the 5-yard mark, the wide hip width group was significantly faster than the medium hip width group when all subjects started from a wide lateral foot placement.

At the 25-yard mark the subjects classified as having wide hip widths did significantly better than the subjects classified as having medium hip widths when all subjects started the sprints from a narrow lateral foot placement. When all subjects began the sprints from a medium lateral

TABLE VIII

U VALUES FOR THE COMPARISONS OF THREE HIP WIDTH CLASSIFICATIONS N=16

Distance	Lateral Foot Placement	Narrow and Medium Comparison N=13*	Narrow and Wide Comparison N=6**	Medium and Wide Comparison N=13*
5-Yards	Wide	10	2	0*
25-Yards	Narrow	8	2.5	0*
	Medium	7	0*	0*
50-Yards	Narrow	9	0*	0*
	Medium	5	0*	0*
	Wide	11	2	1*

*U of ≤3 needed for .05 level of significance
**U of 0 needed for .05 level of significance

foot placement, the wide hip width group sprinted faster than both the narrow and medium hip width groups. U values indicated a .05 level of significance.

At the 50-yard mark the wide hip width group did significantly better than the narrow and the medium hip width groups when starting the sprints from both the narrow and medium lateral foot placements. In addition, the wide hip width group yielded significantly faster times than the medium hip width group from the wide lateral foot placement. U values of 0 and 1 indicated a .05 level of significance.

The data seemed to indicate that the subjects with wide hip widths had a slight advantage over the subjects with narrow hip widths and a greater advantage over the subjects with medium hip widths in terms of time elapsed at three specific distances.

Hypothesis number five stating that there is no difference because of hip width classification from the three lateral foot placements at the 5-yard, 25-yard and 50-yard marks was rejected on the following bases: (1) at the 5-yard mark, when the sprints were started from a wide lateral foot placement, there was a significant difference among the three hip width classifications; (2) at the 25-yard mark, when the sprints were started from both the narrow and medium lateral foot placements, there was a

significant difference among the three hip width classifications; (3) at the 50-yard mark, when the sprints were started from all three lateral foot placements, there were significant differences among the three hip width classifications.

The subjects with narrow and medium hip widths seemed to respond very similarly in time elapsed from the three lateral foot placements at all three distances. However, interesting results occurred among the subjects with wide hips. They performed better than the narrow hip width group in time elapsed at the 25-yard and 50-yard marks from the medium, and medium and narrow lateral foot placements respectively. The wide hip width group also performed better than the medium hip width group in time elapsed from all three distances. As these distances increased, the wide hip width group seemed to yield faster times from a greater number of lateral foot placements. For example, at the 5-yard mark, the wide hip width group performed better than the medium hip width group from one lateral foot placement, wide. At the 25-yard mark, they were superior from the two lateral foot placements, narrow and medium. At the 50-yard mark, their times indicated better performance from all three lateral foot placements.

In the writer's opinion, the results may have been due to a wide hipped athlete possessing a larger structural

framework with corresponding musculature, yielding greater strength. Since strength is a factor in short sprint races, the wide hipped sprinters may have had a strength advantage.

There seemed to be no difference between the narrow and medium hip width groups. The differences began to occur as the hip widths became wider. In the writer's opinion, these results hint at a possibility that there exists a point at which the probability of success in short sprints increases with increasing hip widths. Additional studies are needed which isolate hip width as a specific factor involved in sprinting.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary. A pilot study was undertaken in the spring of 1971 in which two members of the girl's track team at Grimsley High School, Greensboro, North Carolina, served as subjects. The pilot study offered a means for experimenting with the procedures and the equipment necessary in the major study.

In the fall of 1971 sixteen high school female track athletes in three western Connecticut high schools served as subjects for the major study. Each subject participated in nine training sessions and one testing session. The training sessions were designed to familiarize the subjects with three lateral foot placements used in a sprint start. The three lateral foot placements, narrow, medium and wide, were determined relative to each subject's trochanter width. The narrow lateral foot placement was determined by setting the malleoli apart a distance equal to twenty-five percent less than trochanter width. The medium lateral foot placement was determined by aligning the malleoli with the trochanters in a vertical plane. The wide lateral foot placement was determined by setting the malleoli apart a distance equal to twenty-five percent greater than the trochanter width.

Specially designed starting blocks were constructed for use in the study. The front block measured fifteen inches in width allowing for the three lateral foot placements.

The data were collected by using three electric time clocks connected to three photoelectric systems placed at distances 5-yards, 25-yards and 50-yards from the starting line. The clocks were activated by a switch when the subject removed her foot from the back starting block. The clocks were stopped when the subject ran past the photoelectric systems breaking the light beam.

Each subject ran six 50-yard sprints, two from each lateral foot placement. The times for the two sprints from each lateral foot placement at the three distances were averaged and considered as the subject's score.

The data were statistically analyzed by analysis of variance to determine (1) the effect of three lateral foot placements on starting times and sprinting times, (2) the effect of the order in which the trials were run and (3) the effect of three hip width classifications on starting times and sprinting times.

Conclusions. Within the scope of this study the following conclusions have been made:

1. There was no difference in the time elapsed from a starting point to a 5-yard distance using three different

lateral foot placements.

2. There was no difference in the time elapsed from a starting point to a 25-yard distance using three different lateral foot placements.

3. There was a difference in the time elapsed from a starting point to a 50-yard distance using three different lateral foot placements.

The use of the narrow and the medium lateral foot placements resulted in faster times than the use of the wide lateral foot placement at a 50-yard distance.

4. There was a difference in the order in which the sprints were run.

At a 50-yard distance, the first trial resulted in a faster mean time than the last trial.

5. There was a difference because of hip width classification from the three lateral foot placements at the 5-yard, 25-yard and 50-yard marks.

Subjects classified as having wide hips ran five yards from the wide lateral foot placement, twenty-five yards from both the narrow and medium lateral foot placements and fifty yards from all three lateral foot placements faster than subjects classified as having medium hips.

Subjects classified as having wide hips ran twenty-five yards from the medium lateral foot placement and fifty yards from both the narrow and medium lateral foot placements faster than subjects classified as having narrow hips.

The use of three specific lateral foot placements did not seem to be a factor involved in 5-yard starting time and 25-yard sprinting time. However, the use of both the medium and narrow lateral foot placements seemed to offer the runner an advantage, in time elapsed, over the wide lateral foot placement at a 50-yard sprinting distance. In the writer's opinion, variables such as acceleration rate, efficient running stride and force exerted against the starting blocks may have been factors contributing to this advantage. When running 50-yards, female sprinters may find it advantageous to laterally position their feet on the starting blocks either hip width or twenty-five percent narrower than hip width apart.

When running six repetitions of a 50-yard sprint, a difference in the order in which the trials were run occurred only at the 50-yard mark. The times recorded for the first trial were significantly faster than those recorded for the last trial.

Subjects classified as having wide hips seemed to have an advantage in time elapsed over subjects classified as having both medium and narrow hip widths. Hip width may be a factor associated with success in sprinting short distances. These results do not rule out the possibility that success in sprinting may correlate with the factor of hip width for female track athletes. Additional studies are needed to investigate this possibility.

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APPENDIX A

TRAINING PROCEDURES

TRAINING SESSIONS

Session 1 Order of execution of the runs: medium placement, narrow placement, wide placement

1. Meet with the girls and explain the experiment emphasizing that they will train in three lateral foot placements from the medium starting position so that they will be able to perform all three with ease. Briefly explain the training sessions.

2. Ask questions relative to track and field to put the girls at ease and to give them a chance to talk informally.

3. Take the following measurements and record the data on cards. Also record the information on a master data sheet.
    a. Trochanter width
    b. Length of leg from trochanter to floor
    c. Height
    d. Weight
    e. To-to-toe measurement in a medium start position
    f. Distance of the hands to the front foot in a "set" position

4. Have the girls record the following information
    a. Name
    b. Age (year and months)
    c. Track experience
    d. Twenty-five percent of the trochanter width added to the trochanter width and subtracted from the trochanter width
    e. Preferred front foot
    f. Name of partner

5. Explain the starting blocks in general; demonstrate the adjustments; explain how to read the gauge. Every girl will have one set of blocks. Allow time for them to become familiar with their blocks.

6. Demonstrate how to place the feet on the blocks in relation to the hip width measurements by reading the gauge.

7. Have the subjects try placing their feet on the blocks. Have the partners correct for errors.

Each girl places her foot three times on each of the three lateral positions in this order medium, narrow and wide.

8. Emphasize that it is very important for the subjects not to perform any track starts at all except during the training sessions.

Equipment: tape measure, anthropometric caliper, scale, blocks, data cards, pencils, hammers, clip board and master data sheet

After the session, check all data cards for full information. Check the master data sheet with the data cards. Mark each set of starting blocks with colored tape and the names of the girls using the blocks.

Session 2 Order of execution of the runs: wide placement, narrow placement and medium placement

1. Jog 200 yards
2. Stretching exercises for ankle flexibility
3. Distribute the blocks to partners and explain the tape markings on the blocks. Explain the foot placement in relation to the tape markings.
4. Demonstrate the proper method of backing into the blocks, the proper placement of the hands, the fixed angle of the knee (use angle finders) and the proper eye focus (three feet in front of the starting line).
5. Subjects will work with partners taking their marks and moving to a set position, 3 at each lateral foot position. Partners will correct errors.
6. Run 5 yards, 2 at each lateral foot position.
7. Sprint 25 yards, 1 from each lateral foot position.

Equipment: tape measure, blocks, hammers, angle finders, data cards

Session 3 Order of execution of the runs: narrow placement, medium placement, wide placement

1. and 2 same as Session 2
3. Distribute the blocks.
4. Run 10 yards, 3 from each lateral foot position.
5. Correct each subject's position, emphasize the supporting role of the arms and the push from both feet.

6. Sprint 15 yards, 2 from each lateral foot position.
7. Sprint 25 yards, 1 from each lateral foot position.

Equipment: Same as Session 2.

Session 4 Order of execution of the runs: wide placement, medium placement, narrow placement

1, 2 and 3 same as Session 3.
4. Sprint 15 yards, 2 from each lateral foot position.
5. Emphasize the size of the first step. It is important not to have the first step too short.
6. Run 10 yards, 3 from each lateral foot position.
7. Sprint 50 yards, 1 from each lateral foot position.

Equipment: Same as Session 2.

Session 5 Order of execution of the runs: medium placement, wide placement, narrow placement

1, 2 and 3 same as Session 3.
4. Run 10 yards, 1 from each lateral foot position.
5. Emphasize relaxed head position and low angle of body lean on the first few steps.
6. Sprint 15 yards, 2 from each lateral foot position.
7. Sprint 25 yards, 2 from each lateral foot position.
8. Sprint 50 yards, 1 from each lateral foot position.

Equipment: Same as Session 2.

Session 6 Order of execution of the runs: narrow placement, wide placement, medium placement

1, 2 and 3 same as Session 3.
4. Run 3 yards, 2 from each lateral foot position with resistance. Partner offers resistance by placing her hands on the runner's shoulders and running backwards.
5. Run 5 yards, 2 from each lateral foot position.
6. Sprint 25 yards, 1 from each lateral foot position.
7. Sprint 50 yards, 1 from each lateral foot position.

Equipment: Same as Session 2.

Session 7 Order of execution of the runs: wide placement, narrow placement, medium placement.

1, 2 and 3 same as Session 3.
4. Run 10 yards, 1 from each lateral foot position.
5. Sprint 15 yards, 2 from each lateral position.
6. Sprint 25 yards, 2 from each lateral position.
7. Sprint 50 yards, 1 from each lateral position.

Equipment: Same as Session 2.

Session 8 Order of execution of the runs: narrow placement, wide placement and medium placement

1, 2 and 3 same as Session 3.
4. Run 10 yards, 2 from each lateral foot position.
5. Sprint 50 yards, 2 from each lateral foot position.

Equipment: Same as Session 2.

Session 9 Order of execution of the runs: medium placement, narrow placement, wide placement

1, 2 and 3 same as Session 3.
4. Run 5 yards, 2 from each lateral foot position.
5. Sprint 25 yards, 2 from each lateral foot position.
6. Sprint 50 yards, 1 from each lateral foot position.

Equipment: Same as Session 2.

APPENDIX B

DATA

TABLE IX

SUBJECTS' PERSONAL DATA SHEET

	Subject	Age Yrs. and Mo.	Year in School	Height	Weight	Leg Length
1.	C. Gallichotte	15.4	10	5'4"	96	34"
2.	J. Berls	17.2	12	5'5 1/2"	135	34"
3.	P. Pimpinello	16.1	11	5'3 1/2"	125	33 1/2"
4.	J. DeSilva	15.6	10	5'4 1/2"	100	33"
5.	P. Berls	15.8	10	5'4"	104	33 1/2"
6.	P. Ottaul	16.3	11	5'7"	120	34"
7.	K. Ottaul	16.3	11	5'6 1/2"	120	33 1/2"
8.	C. Holmes	16.2	11	5'8 1/2"	125	35"
9.	N. Byrne	15.7	10	5'5 1/2"	128	32 1/2"
10.	K. Keyes	15.5	10	5'	100	31 1/4"
11.	S. Becker	15.9	11	5'5"	110	33 3/4"
12.	K. Keyes	17.8	12	5'2"	108	30 1/2"
13.	N. Drummond	16.3	11	5'9"	140	35"
14.	R. Anthony	15.1	10	5'4"	125	34"
15.	P. Morris	16.7	11	5'7 1/2"	122	33"
16.	D. Odgen	16.2	11	5'3"	103	32 1/2"

TABLE IX--Continued

Subject	Toe to toe Measure	Trochanter Width	25% less Trochanter Width	25% more Trochanter Width	Hands to Front foot Measure
1. C. Gallichotte	18"	11.4"	8.5"	14.2"	11"
2. J. Berls	18 1/2"	13.5"	10.1"	16.9"	11"
3. P. Pimpinello	15 1/2"	13.1"	9.8"	16.4"	10"
4. J. DeSilva	17"	11.5"	8.7"	14.3"	10 1/2"
5. P. Berls	16 1/2"	11.6"	8.7"	14.5"	10 1/2"
6. P. Ottaul	18"	13.0"	9.75"	16.2"	13"
7. K. Ottaul	18"	13.0"	9.75"	16.2"	13"
8. C. Holmes	17 1/2"	12"	9.0"	15.0"	10"
9. N. Byrne	16 1/2"	12.3"	9.2"	15.4"	9"
10. K. Keyes	15"	12"	9.0"	15.0"	10 1/2"
11. S. Becker	16 1/2"	11.8"	8.8"	14.7"	10"
12. K. Keyes	16"	12.5"	9.4"	15.6"	10 1/2"
13. N. Drummond	18"	13.5"	10.1"	16.9"	13"
14. R. Anthony	18"	12.1"	9.1"	15.1"	10 1/2"
15. P. Morris	17"	13.2"	9.9"	16.5"	13"
16. D. Odgen	16"	11.2"	8.4"	14"	14 1/2"

TABLE X

TIME SCORES FOR EACH SUBJECT FOR EACH LATERAL FOOT PLACEMENT AT THE 5-YARD, 25-YARD AND 50-YARD MARKS*

Subject	5-Yards			25-Yards			50-Yards		
	N	M	W	N	M	W	N	M	W
1.	1.07	1.035	1.10	4.06	4.055	4.23	7.435	7.205	7.72
2.	.895	.905	.93	3.675	3.65	3.715	6.67	6.54	6.795
3.	.98	1.035	1.035	3.91	3.92	3.975	7.15	7.21	7.195
4.	.965	.925	.94	3.67	3.68	3.67	6.74	6.74	6.79
5.	1.02	1.28	1.03	3.935	4.025	4.08	6.91	7.165	7.44
6.	1.00	.925	1.01	3.84	3.88	3.87	6.825	6.905	6.895
7.	.96	.965	.995	3.98	3.905	3.94	7.14	6.955	7.13
8.	1.01	1.005	.95	4.04	4.06	4.025	7.38	7.415	7.365
9.	.97	.98	.935	3.87	3.84	3.815	6.895	6.895	6.745
10.	.95	.93	1.015	3.905	3.91	3.985	7.105	7.025	7.23
11.	1.00	1.015	1.01	3.995	4.035	4.055	7.265	7.34	7.32
12.	1.035	1.045	1.04	4.09	4.08	4.155	7.405	7.38	7.66
13.	.93	.84	.90	3.725	3.64	3.695	6.69	6.54	6.62
14.	1.13	1.13	1.235	4.095	4.11	4.78	7.455	7.65	7.84
15.	.985	.985	.91	3.62	3.605	3.545	6.67	6.485	6.52
16.	.94	.91	.905	3.72	3.655	3.68	6.695	6.62	6.765

*Time in seconds, average of two sprints from each lateral foot placement

TABLE XI

LATERAL FOOT PLACEMENT AND TRIAL TIMES FOR EACH SUBJECT AT THE 5-YARD, 25-YARD AND 50-YARD MARKS*

Sub-jects	Trial 1 Yards			Trial 2 Yards			Trial 3 Yards			Trial 4 Yards			Trial 5 Yards			Trial 6 Yards		
	5	25	50	5	25	50	5	25	50	5	25	50	5	25	50	5	25	50
1	M 1.06	4.20	7.60	M 1.01	3.91	6.81	W 1.15	4.25	7.51	N 1.05	3.98	7.23	W 1.05	4.21	7.93	N 1.09	4.14	7.64
2	M .86	3.62	6.45	W .98	3.74	6.93	N .94	3.70	6.81	W .88	3.69	6.66	N .85	3.65	6.53	M .95	3.68	6.63
3	W 1.05	3.99	7.21	N 1.02	4.09	7.42	W 1.02	3.96	7.18	N .94	3.73	6.88	M 1.04	3.86	7.21	M 1.03	3.98	7.21
4	N 1.04	3.73	6.86	W .95	3.64	6.67	N .89	3.61	6.62	M .95	3.72	6.84	M .90	3.64	6.64	W .93	3.70	6.91
5	N .98	3.79	6.73	M 1.47	4.01	7.01	M 1.09	4.04	7.32	W 1.04	4.12	7.67	N 1.06	4.08	7.09	M 1.02	4.04	7.21
6	W .98	3.83	6.83	N 1.03	3.86	6.83	M 1.00	3.91	6.96	M .85	3.85	6.85	W 1.04	3.91	6.96	N .97	3.82	6.82
7	M .96	3.91	6.96	M .97	3.90	6.95	W 1.05	3.92	7.10	N .97	4.01	7.20	W .94	3.96	7.16	N .95	3.95	7.08
8	M .96	3.92	7.14	W .87	3.96	7.29	N 1.01	4.00	7.35	W 1.03	4.09	7.44	N 1.01	4.08	7.41	M 1.05	4.20	7.69

TABLE XI--Continued

Subjects	Trial 1 Yards			Trial 2 Yards			Trial 3 Yards			Trial 4 Yards			Trial 5 Yards			Trial 6 Yards		
	5	25	50	5	25	50	5	25	50	5	25	50	5	25	50	5	25	50
	W			N			W			N			M			M		
9	1.01	3.83	6.75	1.02	3.83	6.79	.86	3.80	6.74	.92	3.91	7.00	.95	3.78	6.82	1.01	3.90	6.97
	N			W			N			M			M			W		
10	1.00	3.96	7.18	1.00	3.88	7.05	.90	3.85	7.03	.87	3.89	7.02	.99	3.93	7.03	1.03	4.09	7.41
	W			N			M			M			W			N		
11	1.01	4.04	7.25	1.00	3.96	7.16	1.00	4.02	7.24	1.03	4.05	7.44	1.01	4.07	7.39	1.00	4.03	7.37
	N			M			M			W			N			W		
12	1.05	4.04	7.22	1.05	4.10	7.38	1.04	4.06	7.38	1.05	4.10	7.68	1.02	4.14	7.59	1.03	4.21	7.64
	M			M			W			N			W			N		
13	.85	3.61	6.46	.83	3.67	6.62	.95	3.72	6.71	.97	3.70	6.71	.85	3.67	6.53	.89	3.75	6.67
	M			W			N			W			N			M		
14	1.12	4.13	7.60	1.22	4.16	7.68	1.16	3.61	7.45	1.25	5.40	8.00	1.10	4.10	7.46	1.14	4.09	7.70
	W			N			M			M			W			N		
15	.90	3.53	6.44	.97	3.54	6.49	.99	3.56	6.38	.98	3.65	6.59	.92	3.56	6.60	1.00	3.70	6.85
	N			M			M			W			N			W		
16	.99	3.77	6.89	.95	3.70	6.68	.87	3.61	6.56	.89	3.61	6.48	.89	3.67	6.50	.92	3.75	7.05

*Lateral Foot Placement: N=narrow, M=medium, W=wide. Time in seconds

TABLE XII

MEAN TIME FOR THREE HIP WIDTH CLASSIFICATIONS AT A 5-YARD, 25-YARD AND 50-YARD DISTANCE FROM THREE LATERAL FOOT PLACEMENTS*

Distance	Narrow Foot Placement			Medium Foot Placement			Wide Foot Placement		
	Narrow Hip	Medium Hip	Wide Hip	Narrow Hip	Medium Hip	Wide Hip	Narrow Hip	Medium Hip	Wide Hip
5-Yard	.991	1.005	.937	.957	1.031	.91	.982	1.025	.913
25-Yard	3.817	3.966	3.671	3.796	3.976	3.632	3.86	4.068	3.651
50-Yard	6.956	7.153	6.676	6.855	7.194	6.521	7.091	7.282	6.645

*Time in seconds