INFLUENCE OF SPRINT START ON STRIDE LENGTH

A Biomechanical Analysis of Movement

ABSTRACT

This study was performed to study the influence of starting block positions on the sride length of a sprinter. A total of 46 male and female athletes between the age group of 18 and 22 were selected for the study. The athletes were allocated into two groups – one using the bunch start and the other using the medium start technique. A kinematic video camera was used to record the time, velocity step length and cadence of the sprinters at the 5 metres interval. The data documented were analyzed for correlation and difference in means. The results of the study showed that the medium start technique had a better advantage over the bunch start technique, in increasing the stride length of the athlete.

Keywords: *sprint, starting blocks, bunch start, medium start, stride length*

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INTRODUCTION

Sprinting is an athletic event, where in a relatively short distance is covered in the least possible time. It is one of the eye-catchers of all track events, for its brevity and worldwide audience. The athletes to have clocked the least time in completing a 100 metre sprint are Usain Bolt from Jamaica (9.58 seconds) and Florence Griffith-Joyner from The United States of America, (10.49 seconds) in the male and female category respectively. (IAAF, 2015)

In sprinting, the initial velocity of the sprinter is much lower than the finishing velocity. The transition from the resting position to fast running is what determines the time taken to complete the sprinting activity. For this, a perfect sprint-start is important, to reduce the transition time.

There are three phases to the sprint start; "*on your marks*", "*set*" and "*go*." (Drew Harrison, 2005) In response to the "*on your marks*" command, the athlete's hands and feet are placed on the ground, and the knees touch the ground. On hearing the "*set*" command, the athlete extends the knee of the leg in the rear, thus elevating the body's centre of gravity, hands and feet still on ground. In the "*go*" phase, the athlete lifts the hands of the ground, and propels his body forward, to begin his sprint.

In international sprinting events, the athlete usually adapts a crouched stance for sprint start. (IAAF, 2015) The starting crouch might be of three types, depending on the relative distance of the back foot with respect to the front foot. This distance is commonly referred to as "inter-block spacing", i.e. the distance between the two starting blocks of the athlete.

There are three types of sprint start.

1. Bunch or Bullet Start, where the front and back toes are separated by not more than 30 com (Drew Harrison, 2005) giving the appearance of bunched legs and body.

2. Elongated Start, where the front and back toes are separated by 60-70 cm. (Drew Harrison, 2005) The knee of the back feet is behind the heel of the front foot, thus giving the elongated appearance
3. Medium start, where the front and back toes are separated by 40-55 cm. (Drew Harrison, 2005) This is in-between the other two types. The knee of the back feet is placed along with the forefoot of the front foot,

As the proverbial saying goes "well begun is half done", an effective sprint start reduces the time taken by the athlete to cover the sprinting distance. (Bezodis, 2009) So, which of the three sprint start techniques more effective in producing greater impulse? Applying the Newton's Second Law of Motion, and the Impulse momentum relationship, it can be derived that the impulse of force is equal to the change in momentum that it produces. The change in momentum is the change from the initial to the final velocity of the athlete during the sprint (Warden, 2003) states that the greater the impulse of force produced by the athlete, greater the velocity, thus lesser the time taken to finish the sprint.

The need for this study is to make the sports students aware of the difference in the efficacy of the different sprint start techniques, and to let them decide on the most effective technique of their choice. Two techniques – The bunch technique and the medium technique were taken up for the study. The Initial and final stride length of the athletes was taken as the parameter for assessing the technique's efficacy, in both male and female students.

The objective of this study is to determine the influence of the type of sprint start on the stride length of a sprinter.

Research hypothesis - "There is a significant improvement in stride length in medium start technique when compared to bunch start technique."

DESIGN & METHODOLOGY

Study Design – Quasi Experimental

Study Setting – Department of Life Sciences, Roehampton University.

Sample Size – Total n=46 (Group A n=23, Group B n=23)

Sampling Technique – Convenient Sampling, Randomised Group Allocation

Selection Criteria

- Inclusion
    1. Medically Stable Athletes, who have undergone sprinting training
    2. Both Male and Female Individuals between the age group of 17 and 22
- Exclusion
    1. Individuals with physical fitness issues like abdominal, leg muscle cramps, upper and lower extremity fractures etc

Variables

- Independent – Technique of Sprint Start - Bunch, Medium
- Dependant – Distance Covered by the athlete, Velocity, Stride Length, Cadence

Materials Required

1. A digital video camera with a kinematic lens
2. Tripod for mounting the camera
3. Stopwatch

Preliminary Clearances

The research procedure was thoroughly explained to the athletes, and an informed written consent was obtained in their vernacular language. They were allocated into 2 groups – Group A (Bunch Start) and Group B (Medium Start) by Random Allocation Software.

Preparations

A digital video camera is mounted on a 12 feet tall tripod, 10 metres away from the running track. 360 degrees of rotation is enabled for the camera, for which the shutter speed was set at 1/250 seconds. The start point (0.0 metres) and the data collecting point (5 metres) are marked by placing cones at the corresponding distances.

Research Procedure

Prior to the sprinting activity, the individuals of both groups are given a warm-up session of 5 minutes. The starting blocks are placed behind the starting point, and are calibrated for each individual for bunch start type. The Group A athletes are given the “on your marks”, “set” and go” commands, and the time, velocity, stride, and step parameters are captured. The procedure is repeated with the Group B athletes, by setting the starting blocks to the “medium start” positions. The athletes are given a 5 minute cool down session.

The data that is recorded in the camera is documented using stopwatches, and is analysed.

DATA ANALYSIS AND RESULTS

The outcome values obtained, were tabulated in Microsoft Excel ’07 spreadsheet, and were exported to GraphPad Prism 5 for Windows Version 5.03, for statistical analysis.

Paired t-tests were performed to determine whether the mean of the dependent variables chosen (Stride Length) is different for the two starting types.

A Pearson’s Product-Moment Correlation was performed, to measure the strength of the linear association between the stride lengths in starting type.

The P value was chosen as per the description given by GraphPad Prism 5 for Windows Version 5.03.

Table 1 - Baseline Characteristics of the athletes

Characteristics		Group A (Bunch Start)	Group B (Medium Start)
Total Number of participants		23	23
Age (years)		18	19.73 (1.48)
Gender	Male	15	16
	Female	8	7
Height (metres)		1.74 (0.11)	1.74 (0.11)
Mass (kilograms)		71.78 (13. 89)	71.73 (13.89)

Table 2 - Analysis of the Stride Length – Initial and Final

The parameters chosen for the study – the first and the final stride length, were analysed for both the groups of n=23 each, and for an individual participant from each group.

	Bunch		Medium	
Variable	Group	1 Participant	Group	1 Participant
First Stride Length	1.06 (0.1)	1.11	0.97 (1.7)	0.97
Final Stride Length	1.62 (0.6)	1.46	1.52 (1.8)	1.46

Figure 1 - Velocity-time results over 5m in both types of sprint starts

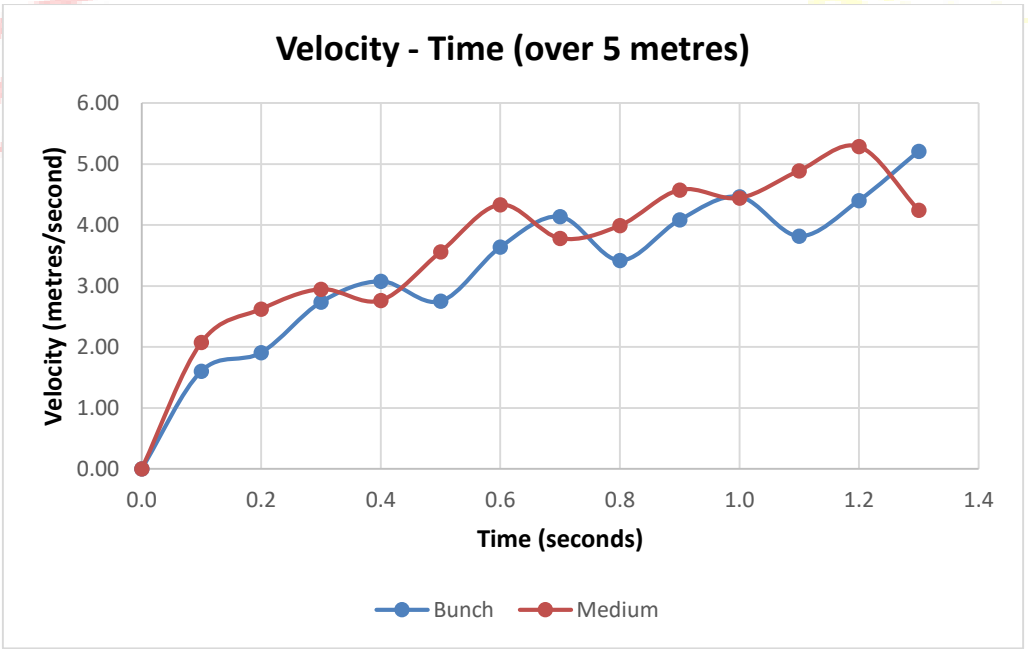


Table 3 – Analysis for comparing the means

A Paired t-test was conducted between the two parameters to compare the means in both the groups separately.

Group	Analysis	Mean (SD)	"t" value	Significance "P" value
Bunch Start	First Stride Length	1.06 (0.1)	10.4971	***
	Final Stride Length	1.62 (0.6)		
Medium Start	First Stride Length	0.97 (1.6)	2.2163	**
	Final Stride Length	1.52 (1.8)		

The results of the study from the above table indicate that: in both groups, the difference between the means is considered to be statistically significant by conventional criteria.

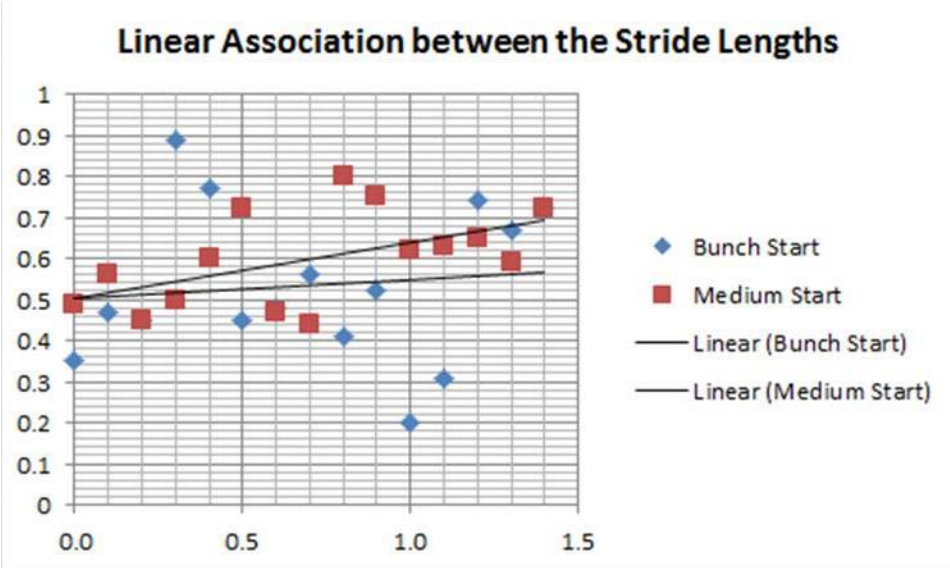
Table 4 – Analysis for measuring the linear association between the two stride lengths

A Karl - Pearson's Correlation was done to measure the strength of the linear association between the stride lengths in each start.

Group	Analysis	Mean (SD)	Correlation "r" value
Bunch Start	First Stride Length	1.06 (0.1)	0.2228
	Final Stride Length	1.62 (0.6)	
Medium Start	First Stride Length	0.97 (1.6)	0.6854
	Final Stride Length	1.52 (1.8)	

The results of the study from the above table indicate that: in though there is a positive correlation between the stride lengths of both groups, the stride lengths of the group using the medium start technique shows a moderately higher co-efficient of correlation than that of the Bunch start technique, which showed a weakly positive correlation co-efficient.

Figure 2 – Analysis for measuring the linear association between the two stride lengths



DISCUSSION

The journey of thousand miles begins with a single step. In a sprint, the increase in the ground surface covered with each step is an important tool in finishing the race faster.

This study was conducted in healthy young athletes, to evaluate the influence of the sprint start technique on their stride length during sprinting. The results of this study show that the medium sprint start is more effective in the improvement of stride length of the athlete than the bunch start technique. This is supported by many studies. (Hunter, 2004), (Bezodis, 2009), (Slawinski, 2012), (Cowburn, 2005).

One of the main reasons attributed to the slight advantage the medium start has over the bunch start is the impulse of force exerted by the athlete.

Impulse and the Sprinter

For the athlete to run when the gun is fired "GO", he/she must produce a considerable force, over a period of time. This is achieved when his/her body is in the "Set" phase. (Warden, 2003)

Going by Newton's Second Law of Motion,

Where "F" is the force generated, "m" is the mass of the object and "a" is $F = ma$ the acceleration of the object due to gravity.

Given that "a" is equal to the difference between the initial and final velocities by the time taken, (v_f and v_i respectively.)

$$F = m*(v_f - v_i)/t$$

$$\text{»}\ F = (mv_f - mv_i)/t$$

$$\text{»}\ Ft = (mv_f - mv_i)$$

This equation implies that the impulse of the force is equal to the change in momentum that it produces. (Warden, 2003) (Drew Harrison, 2005)

In the Bunch technique, the time period in which the athlete's feet are in contact with the starting blocks is very limited, thus reducing the time taken to exert force. However, in the medium start technique, there was enough time for the athlete to generate force sufficient enough to speed up his sprint. Thus, the medium start technique is slightly advantageous over the bunch start technique.

Stride Length and the Sprinter

The aim of any sprinting activity is to cover the given distance in the shortest possible time. The lesser number of steps taken or longer distance between each step, helps the athlete to clear more of the distance in a shorter span of time. However, Stride Length is dependent on various factors such as Leg length, Height and the typical posture of an athlete. In this study, all athletes had an average of 1.74 metres. This study could be further progressed by analyzing the stride length of individuals of varying heights.

Limitations of the Study

One of the main limitations of this study was that only two types of sprint starts were analysed, when there are three that are recognized. A study analyzing the elongated start in addition to the bunch and medium start will bring out the platform to analyse the advantages and disadvantages of each and every technique, though the medium start is seen in above cited studies to have a higher advantage among the three techniques as well.

The sample size used was 46, with 23 athletes in each group. The gender ratio is sqewed in favour of male athletes, so a gender based analysis could not be performed. Performing this study on equal number of participants from both genders would help analyse the influence of

gender on the individual performance. The number of participants can be increased so there are less chances of an estimation error. This study could be expanded further to accommodate more athletes, from different ethnicities, to have a broader perspective on the issue.

CONCLUSION

From this study it can be concluded that the medium start technique has a better influence on the stride length of the individual when compared to the bunch start technique, thus proving the research hypothesis.

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APPENDICES

Appendix 1 - Description of P value

P value	Description	Summary
< 0.001	Extremely Significant	***
0.001 to 0.01	Very Significant	**
0.01 to 0.05	Significant	*
> 0.05	Not Significant	ns

Appendix 2 – Raw Data of Velocity over Time at 5 metres

Velocity over Time (at 5 metres)	
Bunch Start	Medium Start
0.00	0.00
1.60	2.07
1.91	2.62
2.74	2.95
3.08	2.76
2.75	3.56
3.64	4.33
4.14	3.78
4.40	5.29
5.21	4.24

Appendix 3 – Raw Data of the stride lengths in both groups

Group A (Bunch Start)		Group B (Medium Start)	
First Stride Length	Final Stride Length	First Stride Length	Final Stride Length
1.11	1.46	0.97	1.46
1	1.47	0.94	1.5
1.15	1.5	1.11	1.56
1.12	1.91	1.1	1.6
0.99	1.78	1.1	1.7
1.09	1.5	0.45	1.12
0.96	1.52	0.98	1.45
0.95	1.69	0.95	1.43
1.24	1.65	1.22	1.57
0.95	1.58	1.04	1.9
1.12	1.45	1.09	1.76
1.13	1.47	0.89	1.49
1.19	1.84	1.04	1.7
1.09	1.75	0.95	1.36
0.74	1.58	1.1	1.34
1.17	1.82	0.92	1.4
0.95	1.58	1.02	1.6
0.89	1.36	0.96	1.44
1.16	1.78	0.98	1.5
1.07	1.8	1.02	1.72
1.11	1.4	0.55	1.22
1.1	1.51	0.94	1.47
1	1.8	1	1.8