P-ISSN: 2394-1685
E-ISSN: 2394-1693
Impact Factor (ISRA): 5.38
IJPESH 2017; 4(1): 38-41
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www.kheljournal.com
Received: 18-11-2016
Accepted: 23-12-2016

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Effects of block placements on stride distance and stride time in sprint start: A kinematical analysis

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Abstract
The aim of the present study is to analyse the kinematics of block placements and its effects on first stride distance and first stride time in sprint start. The selected 30 male sprinters of the Inter University and State teams of Uttar Pradesh were participated for this study. The average age of the sprinters was 22.6 ± 1.1 years, average height 172.6 ± 5.2 centimeters and average weight 74.3 ± 4.2 kilograms, and 5.5 years of track experience. The start analysis system was used to assess the kinematical parameters of the sprint starts and acceleration. The start analysis system consisted of starting blocks modified by attaching milliseconds time sensors, angle analysis system software, and an electronic measurement system with two pairs of photo cells units for measuring the time parameters of the first stride and start acceleration of 30 meters.

Keywords: Block placement, stride distance, stride time, kinematics, male sprinters

Introduction
The main objective of science is the pursuit of knowledge. In the recent era Science is a significant force in the field of sport that search solutions to performance problems. The technology enhances performances by widening the application of these Sciences. The sprint start is a systematic complex motor task characterized by large amount of muscular forces exerted in the diagonally horizontal direction with the application of lever mechanics and by the ability to generate these forces in a short time period. The major training factors affecting these actions are the motor ability and the reaction ability. The starting position is an important aspect of sprint performance from which the location of the center of mass (CM) and horizontal velocity have been identified as descriptors of a good starting block performance. Several other kinetic and kinematic variables such as the rear peak force, the block time, the block leaving velocity and the block leaving acceleration, have been reported as possible parameters influencing starting block performance. The main difference between bunch or bullet, the medium and the elongated starts lies in the longitudinal distance between the toes of the front foot and the toes of the rear foot when the athlete is in the "On your marks" position.

Statement of the problem
The purpose of the present study was to evaluate the kinematics of block placements and its effects on first stride distance and first stride time in sprint start.

Selection of subjects
A total of 30 male sprinters of the Inter University and State teams of Uttar Pradesh were participated for this study. The average age of the sprinters was 22.6 ± 1.1 years, average height 172.6 ± 5.2 centimeters and average weight 74.3 ± 4.2 kilograms, and 5.5 years of track experience.

Selection of variables and criterion measures
a. Block angle. It is the acute angle between the block and the horizontal surface of the track. The measurements were analyzed using software constructed for the research study by incorporating standard geometrical methods and techniques. The values were recorded in degrees.

b. Block clearance time, defined as the time elapsed from the gun signal to clearing the instrumented front block. The time was recorded in 1000th of a second.
c. First stride time, defined as the time from the gun signal to the rear foot contact with the track. The time was recorded in 1000th of a second.
d. First stride distance. It is the distance between the start lines to the first stride. It was measured by using standard measuring tape and recorded in centimetres.

The data were obtained by setting the experimental starting block (start analysis system) on the track of Noida College of Physical Education, Dadri, Uttar Pradesh. Each subject performed three sprint starts at maximum speed from the experimental starting blocks on a distance of 30 meters of each of the three Start techniques. Standard starting commands were used. The sprinters in response to starting gun individually start from the experimental starting block and the similar type – without electronic device – is used in all levels of competitions. The best achieved result in the 30 meters sprint of each individual from each technique was used in the study.

Measurement system and technology

The Start Analysis System was designed to assess the kinematical parameters of the sprint starts and acceleration. The start analysis system consisted of Starting blocks modified by attaching Milliseconds Time Sensors, Angle Analysis System Software, and an Electronic Measurement System with two pairs of Photo Cells units for measuring the time parameters of the first stride and start acceleration of 30 meters. All of the parameters were measured simultaneously.

Fig 1: Time Sensors attached Starting Blocks

The first stride time sensing system includes a pair of photo-electric timing sensors having a series of photo electric cells arranged adjacently so as to break at least three light beams in a foot strike. The milliseconds microcontroller was adjusted in such a way that even breaking of one light beam could sense the time so that accuracy can be maintained throughout. This system was used to sense the time interval between the gun signal and the break in the light beam of photoelectric cells as the rear leg contact with the track as first stride.

Analysis of data

To detect differences between three block space conditions, comparisons were made by treating the data by using Common Descriptive Statistics. The time results were recorded to 1/1000th of a second, distance were recorded to nearest centimetres and angle results were recorded to degrees. All the results are presented in mean scores and standard deviation across all the three block placement conditions for angle of blocks, time of block clearance, first stride distance and time.

Analysis of front block angle (FBA)

Table 1: Descriptive statistics of front block angle (FBA) in the three block space conditions

Conditions	Mean	SD	95% of Confidence Interval	Minimum	Maximum	Range
28±2CM	55.333	3.924	(53.867, 56.798)	50.000	60.000	10.000
46±6CM	50.000	3.713	(48.613, 51.386)	45.000	55.000	10.000
64±4CM	55.500	4.015	(54.000, 56.999)	50.000	60.000	10.000

Table 1 illustrates the mean of front block angle in the 64 ± 4CM (55.5°) block space condition exhibited a 5.5° and 0.2°, higher degree than condition 46 ± 6CM (50°) and condition 28 ± 2CM (55.333°) respectively.

Analysis of rear block angle (RBA)

Table 2: Descriptive Statistics of Rear Block Angle (RBA) in the Three Block Space Conditions

Conditions	Mean	SD	95% of Confidence Interval	Minimum	Maximum	Range
28±2CM	69.500	4.015	(68.000, 70.999)	65.000	75.000	10.000
46±6CM	75.333	3.924	(73.867, 76.798)	70.000	80.000	10.000
64±4CM	79.833	3.591	(78.492, 81.174)	75.000	85.000	10.000

Table 2 illustrates the mean of rear block angle in 28 ± 2CM block space condition (69.500) exhibited a 5.833° and 10.333°, lower degree than condition 46 ± 6CM (75.333º) and condition 64±4CM (79.833º) respectively.

Analysis of block clearance time (BCT)

Table 3: Descriptive Statistics of Block Clearance Time (BCT) in the Three Block Space Conditions

Conditions	Mean	SD	95% of Confidence Interval	Minimum	Maximum	Range
28 ± 2CM	0.487	0.038	(0.472, 0.501)	0.431	0.511	0.080
46 ± 6CM	0.516	0.013	(0.510, 0.520)	0.481	0.537	0.056
64±4CM	0.538	0.018	(0.530, 0.544)	0.499	0.571	0.072

Table 3 illustrates the mean time of block clearance in the 28±2CM block space condition (0.487s) exhibited a 0.029s and 0.051s, quicker reaction time than condition 46±6CM (0.516s) and condition 64±4CM (0.538s) respectively.

Analysis of first stride time (FST)

Table 4: Descriptive Statistics of First Stride Time (FST) in the Three Block Space Conditions

Conditions	Mean	SD	95% of Confidence Interval	Minimum	Maximum	Range
28 ± 2CM	0.551	0.013	(0.546, 0.556)	0.526	0.571	0.045
46 ± 6CM	0.577	0.019	(0.570, 0.584)	0.536	0.602	0.066
64 ± 4CM	0.605	0.021	(0.597, 0.613)	0.547	0.637	0.090

Table 4 illustrates the mean time of first stride in the 28 ± 2CM block space condition (0.551s) exhibited a 0.026s and 0.054s, quicker reaction time than condition 46 ± 6CM (0.577s) and condition 64 ± 4CM (0.605s) respectively.

Analysis of first stride distance (FSD)

Table 5: Descriptive Statistics of First Stride Distance (FSD) in the Three Block Space Conditions

Conditions	Mean	SD	95% of Confidence Interval	Minimum	Maximum	Range
28±2CM	69.833	2.214	(69.006, 70.660)	65.000	73.000	8.000
46±6CM	65.033	2.671	(64.035, 66.030)	59.000	71.000	12.000
64±4CM	51.633	3.418	(50.356, 52.909)	46.000	56.000	10.000

Table 5 illustrates the mean first stride distance in the 28±2 CM block space condition (69.833cm) exhibited a 4.800cm and 18.200 cm, longer distance than condition 46±6CM (65.033cm) and condition 64±4CM (51.633cm) respectively.

Discussion of findings

Block space in 28±2CM produced the mean fastest RT time at 0.487s, 0.029s and 0.051s faster than block space in 46±6CM (0.516s) and block space in 64±4CM (0.538s) respectively. Therefore, it can be concluded that the 28±2CM placements condition allows a faster block clearance because it permits maximum stretch reflex to generate as a single unit for the forthcoming action.

It was also revealed that 28±2CM block placement condition showed better performance in the first stride time (0.550s) than 46±6CM block placement condition (0.577s) and 64±4CM block placement condition (0.605s). The findings of first stride distance have explored a definite relation with all the three block space conditions and the first stride distance. In bunch start, 28±2CM block space condition, the mean distance of first stride is 69.833 centimeters, in medium start, 46±6CM block space condition, the mean distance of first stride is 65.033 centimeters and in elongated start, 64±4CM block space condition, the mean distance of first stride is 51.633 centimeters. This indicates that as the block distance increases the first stride distance decreases.

The results of the analysis of the Front Block Angle showed almost similar block angle, 50° to 55°, in all the three block space conditions revealed that the inclination of the front block is an essential kinematical factor for exerting force against the front block. If the sprinters are keeping more angles in front block he/ she cannot exert maximum force for the initial drive against the front block, so the conclusion is that 50° to 55 ° is the ideal angle for the front block in all the three block space conditions.

In the case of rear block angle the statistical result displayed the difference in all the three block space conditions in which the difference is due to the fact that block has to be kept in proper inclination so that the sprinter can occupy a comfort position when he/she reaches in "set". The result shown that the block angle in the medium block space condition has got the intermediate value as 75.333° (bunch start 69.5° and elongated start 79.833°) thus accepted as an optimum value for the better angle of rear block. The higher angle in the rear block showed that the body weight has to be concentrated in front.

Conclusions

1. Block space in 28±2CM produced the mean fastest RT time at 0.487s, 0.029s and 0.051s faster than block space in 46±6CM (0.516s) and block space in 64±4CM (0.538s) respectively.
2. 28±2 CM block placement condition showed better performance in the first stride time (0.550s) than 46±6 CM block placement condition (0.577s) and 64±4CM block placement condition (0.605s).
3. In Bunch Start the mean distance of first stride was 69.833 centimetres, in medium start the mean distance of first stride was 65.033 centimetres and in elongated start the mean distance of first stride was 51.633 centimetres. This indicates the first stride distance has got an inverse relation to the block distance.
4. 50 ° to 55° is the ideal angle for the front block in all the three block space conditions.
5. The block angle in the medium block space condition has got the intermediate value as 75.333° (Bunch Start 69.5° and Elongated Start 79.833°) thus accepted as an optimum value for the better angle for the rear block. The higher angle in the rear block showed that the body weight has to be concentrated in front.

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