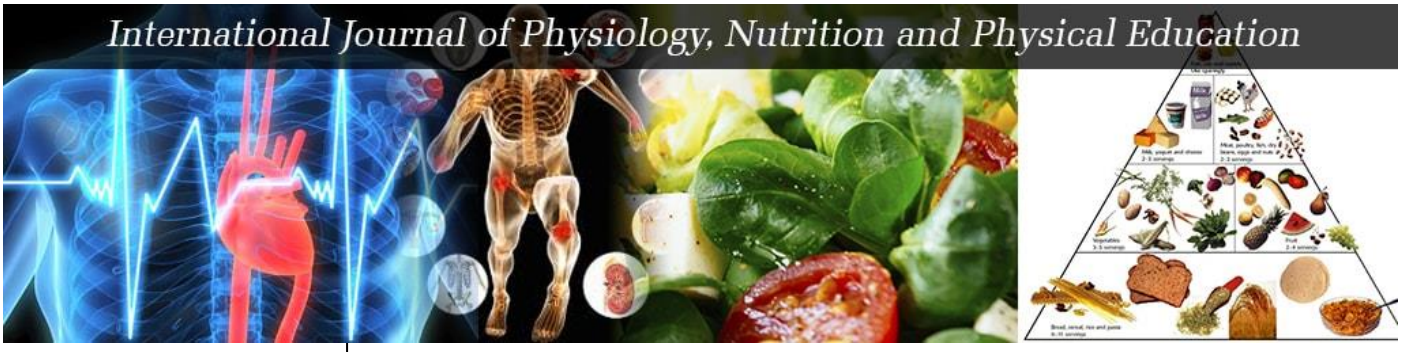

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Kinematics analysis of starting block phase among sprinters

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Abstract
The purpose of the study was to analyse the kinematic of block phase in 100 meter sprinters. To facilitate this study 3 national level athletes were selected as subjects from Kerala state sports council. The age of the subjects were ranged from 18 to 28 years. The study was determined to select the biomechanical variables. The study was formulated as a survey design with 3 subjects. Each athletes performed three block starting performance with maximum level that were video recorded with on camera positioned 5 meter perpendicular to the staring block. Data were collected by analyzing the video recording of each jump. Data processing was performed using the KINOVEA motion analysis software. Collected data were analysed with Mean and Percentile value. The study found that mean values different kinematics parameters such as hip peak angle, hip peak time, knee peak angle, knee peak time, ankle peak angle and ankle peak time involving in 100 m sprint starting block phase.

Keywords: Sprint, kinematics, peak, angle, starting block phase

Introduction
Sprint is a complex motion that engages the whole human body. The effectiveness of this motion (sprint time) determines the level of speed abilities, which are represented by values of kinetic and kinematic variables. The main goal of a sprint is to cover the distance in a shortest possible time through maximization of the horizontal component of velocity of the runner's centre of mass. There are several consecutive phases of a sprint: start, push-off, acceleration and maximum velocity. All the phases are characterized by different technical and physiological demands to maximize motion efficiency (Barr M.J. *et al*., 2013) [7]. Blocks phase is a fundamental component of all track and field sprint events and complex skill characterized by a multi-joint and multi-plane task requiring stretch-shorten cycle type motion and complex muscle coordination in order to reach a large force exerted in the horizontal direction in a short time. (Harland M.J. *et al*., 1995) [3].

The starting technique is greatly influenced by the setting of the block positions with regards to spacing and obliquities. World-class 100 m sprinters can achieve around one-third of their maximum velocity in around only 5% of total race time by the instant they leave the blocks, and sprint start performance is strongly correlated with overall 100 m time. (Bezodis *et al*. 2015) [1] Studies found that the velocity of the centre of mass at block clearing is higher when the inter-block spacing increases due to an increase of force impulse. This is due to an increased duration of force generated against the blocks and a greater contribution of total force impulse from the rear leg. Medium start creates the best balance between total force generated and the increased time of force generation to obtain the best performance in the early acceleration phase (Harland, M. J.*et al*. 1997) [4]. Dickinson stated that the distance of the front block from the starting line should depend on the height of the individual, and the distance of the rear block from the starting line on the leg and the thigh lengths, irrespective of the type of the start used (Dickinson, A. D. *et al*., 1934) [5]. Harland and Steele (1995) [3] stated that, in order to achieve a combination of high force power and high maximum force, the sprinter should position his/her rearknee in the"set" position between 90° and 130° of flexion, with the hips moderately high. Such a setting allows leaving the starting block at a low angle (40° to 45°)which eventually minimisespotential horizontal breaking forces.The study of Coh, Tomazin and Stuhec (2015) [2], which was based on a 2-D kinematic analysis, revealed a

definite correlation between the optimal set position and the maximal block velocity during the start and acceleration out of the blocks. Their findings suggest that the first ten steps are crucial in order to achieve a satisfactory velocity.

Methodology

The purpose of the study was to analyse the kinematic analyse of block phase in 100 meters sprinters. To achieve of this study the three national level athletes were selected from Kerala state sports council, kottayam. The selected subject age ranged between from 18 to 28 years. The nature and importance of this study was explained to the subject and their willingness to participate as subjects for this study and study and procedures of the test were explained in details to subjects so as to obtain reliable data from the subject related block phase. The purpose of the study was delimited for selected biomechanical variables namely hip peak time, peak angle, starting angle and angle at end of the phase, knee peak time, peak angle, starting angle and angle at end of the phase. Ankle peak time, peak ankle, starting angle and angle at end of the phase. The study was formulated as survey design with three subjects.

Procedure of video capturing

The selected variables namely hip peak time, hip peak angle, hip starting angle, hip angle at end of the phase, knee peak time, knee peak angle, knee starting angle, knee angle at end of the phase, ankle peak time, ankle peak angle, ankle starting angle and ankle angle at end of the phase were assessed by video capturing technique. YI camera was used to capture the motion. In this study, the camera was used to capture the block start of the athletes. The camera was placed perpendicular to the stating block at a distance of 5 meters to capture the performance. A YI camera was used to record the trails at 120 frames per second. The camera was mounted on tripod at height of 0.5m from the ground level. It was placed at a distance of 5 meters of from the plane of action. The players were asked to perform block start for three times. The recorded video uploaded to computer in which the video was analysed using KINOVEA 0.8.15 motion analysis software.

Procedures of measuring selected variables

The hip peak time, knee peak time, ankle peak time was used measured with clock tool in the motion analysis software. The hip peak angle, hip starting angle and hip angle at end of the phase, knee peak angle, knee starting and knee angle at end of the phase, ankle peak angle, ankle starting angle and ankle angle at end of the phase was measured with help of goniometry tool in motion analysis software.

Statistical analysis

The collected data was analysed with mean and percentage to find out the block phase kinematics of sprinters.

Results & Discussion

Table 1: Showing the mean and percentile values of hip kinematics of elite level sprinters

Hip	Athlete 1	Athlete 2	Athlete 3	Mean	Percentile
Peak time (seconds)	0.38	0.39	0.33	0.367	0.39
Peak angle (Degree)	78	76	72	75.33	78
Starting angle (Degree)	93	96	91	93	96
Angle at end of the phase (Degree)	133	136	137	135	137

The study was proved that 155 cm mean height of sprinters can maintain their hip peak time 0.367 seconds, hip peak angle 75.33 degree, hip starting angle 93.3 degree and hip angle at the end of phase 135.3 for their sprinting performance in 100m starting block.

Table 2: Showing the mean and percentile values of Knee kinematics of elite level sprinters

Knee	Athlete 1	Athlete 2	Athlete 3	Mean	Percentile
Peak time (Seconds)	0.31	0.29	0.32	0.307	0.32
Peak angle (Degree)	114	116	118	116	118
Starting angle (Degree)	47	43	46	45	47
Angle at end of the phase (Degree)	115	112	117	114	117

The study found that 155 cm mean height of sprinters can maintain their knee peak time 0.307 seconds, knee peak angle 116 degrees, knee starting angle 45.33 degrees and knee angle at end of the phase 114.7 degrees for their sprinting performance in 100 m starting block.

Table 3: Showing the mean and percentile values of ankle kinematics of elite level sprinters

Ankle	Athlete 1	Athlete 2	Athlete 3	Mean	Percentile
Peak time (Seconds)	0.26	0.27	0.22	0.25	0.27
Peak angle (Degree)	66	69	63	66	69
Starting angle (Degree)	58	60	61	59	61
Angle at end of the phase (Degree)	103	106	102	103	106

The results found that 155 cm mean height of sprinter can maintain their ankle peak time 0.25, ankle peak angle 66 degrees, ankle starting angle 59.67 degrees and ankle angle at end of the phase 103.7 degrees for their sprinting performance in 100m starting block.

Recommendations

Further, this study may be conduct on national and international 100 m sprinter with large samples for getting optimal of angle and peak time for standard 100 sprinting performance. And also further study can conduct nation and international level 100 m sprinter with large samples with their morphological measurement with sprinting performance.

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