

# Relationship Among the Technique of Hurdle Clearance Over the Different Hurdles in 110m Race

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**Abstract:** *The 110 meters hurdles are a hurdling track and field event for men. Hurdles are a combination of cyclic sprinting and acyclic clearance of ten 1.067m hurdles. The present studies dealing with the theory and practice of hurdling, was unable to conclude which factors play a decisive role in achieving success. The study was conducted on one male athlete. The kinematical analysis of the technique was performed at the 4<sup>th</sup>, 5<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> hurdle. The study was conducted on 30 biomechanical parameters. Researcher found there was no relation among the selected parameters on all four hurdles (4<sup>th</sup>, 5<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup>) in subject performance. Study concluded it was hard to create single biomechanical model on all selected parameters of study, that applicable to all hurdles of 110m race.*

**Keywords:** Hurdles, Biomechanics, Relationship, Technique, kinematical.

## 1. Introduction

Athletics are one of most famous sports since ancient times. Nowadays athletics are matter of pride along with other sports. In last some decades almost all the records are broken several times. The hurdles race is one of the most exciting races in the sport of track and field. The 110 meters hurdles are a hurdling track and field event for men. Hurdles are a combination of cyclic sprinting and acyclic clearance of ten 1.067m hurdles. During clearing the hurdle, the loss of horizontal velocity must be as small as possible however this depends on numerous factors, especially those which define the take-off before hurdle clearance, the trajectory of the movement of the C.G., and the landing after hurdle clearance. There was closely connection between the motor skills and technical abilities present studies dealing with the theory and practice of hurdling, was unable to conclude which factors play a decisive role in achieving success. Researcher try to examine the biomechanical parameters of Mr. Jashanjot Singh one of the potential athlete of India and tries to understand the relationship among techniques of hurdle clearance over different hurdle. Researcher tries to understand whether single biomechanical model of selected parameters applicable to all hurdles in 110m race.

## 2. Literature Survey

Researcher found that in most of studies it is pointed out that there is complementary development of motor skills (speed, endurance and strength) and the technique of clearing ten hurdles by Doherty (1953), Hoke (1943), McFarlane (1988), Otrubiannikow & Razumowski(1988) Webster(1929). The studies revealed that the physical factors are one of few basic factors which contribute in achieving better results. Sami Kuitunen and Stephen Poon 2010 showed differences in hurdle clearance are very small among world-class hurdle sprinters and the main difference is likely related to achieving and maintaining high horizontal velocity for the hurdle clearance.

## 3. Problem

To understand the Relationship among the technique of hurdle clearance over the different hurdles in 110m race.

## 4. Selection of Subject

The study will be conducted on one male athlete. He is one of the potential athlete of India.

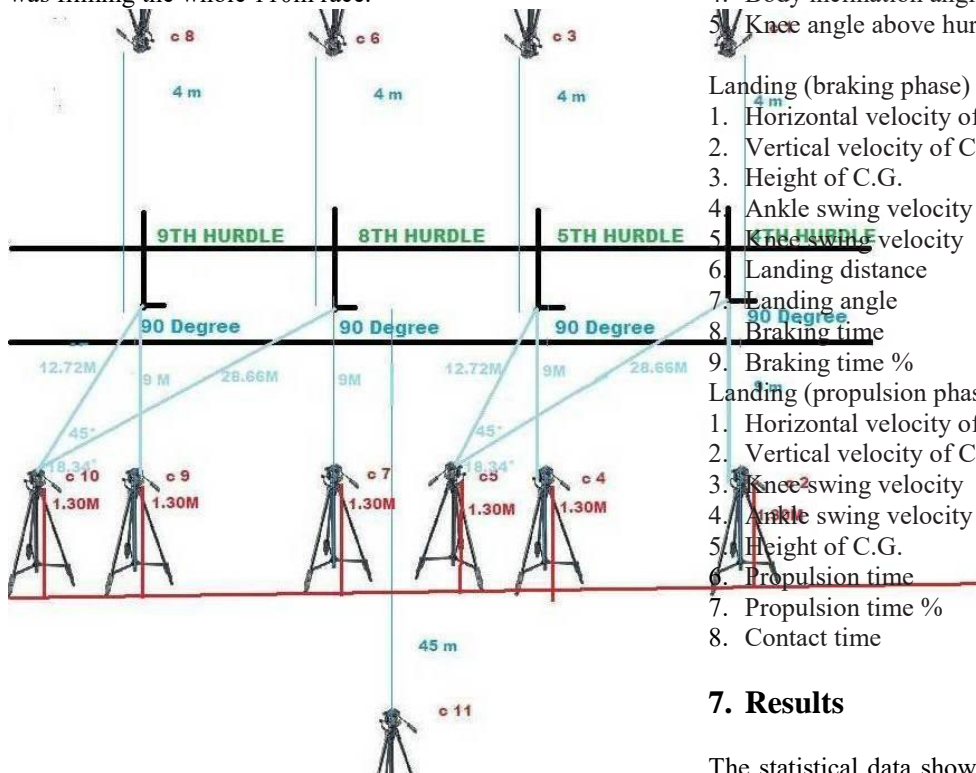
**Table 1:** Bio Data of Subject

Name	Jashanjot Singh	
State	Sangrur Punjab India	
Date of birth	7-02-1995	
Height	1.89 meter	
Weight	73 kg	
Level of participation	National	
Achievements	2 times Junior gold medal, school national U-19 gold medal, federation cup U-20 silver medal, attend India camps two times	

## 5. Procedure and Methods

The measurements were carried out on a War hero's track-and-field stadium Sangrur Punjab on synthetic surface. According to the protocol, athlete performed five runs from starting blocks with the clearance of ten hurdles, set at standard distances from the start. The kinematical analysis of the technique was performed at the 4<sup>th</sup>, 5<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> hurdle. 11 digital High Definitions Panasonic-90 video cameras will be used to record data. One camera is placed 4 meter above form the top of each hurdle (hurdle no. 4, 5, 8 and 9) four cameras are placed on 1.30 meter high and 9 meter far on sideline of each hurdle with 90 degree angle to hurdle. 2 cameras were placed at 45 degree to 5<sup>th</sup> and 9<sup>th</sup> hurdle at 12.72m and at 18.34degree to 4<sup>th</sup> and 8<sup>th</sup> hurdle at 28.66m distance. 1 camera is placed 45 meter far at 90 degree from

the running track record the complete sprint. Camera C1, C2 and C5 was filming the subject at 4<sup>th</sup> hurdle, camera C3, C4 and C5 was filming the subject at 5<sup>th</sup> hurdle, camera C6, C7 and C10 was filming the subject at 8<sup>th</sup> hurdle, camera C8, C9 and C10 was filming the subject at 9<sup>th</sup> hurdle. All the cameras filmed the hurdle clearance by subject on above mentioned hurdle from frontal, lateral and vertical axis. Camera c 11 was filming the whole 110m race.



**Figure 3.1:** Video Camera Set-ups

## 6. Criterion Measures

The researcher had gone through the available literature in detail pertaining to the 110m hurdle race. Keeping the feasible criteria in mind, especially availability of instruments and software, the following biomechanical parameters were chosen for hurdle clearance technique over 4<sup>th</sup>, 5<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> hurdle in 110m race.

### 1. Rhythmic velocity

Take – off (braking phase)

1. Horizontal velocity of C.G.
2. Vertical velocity of C.G.
3. Height of C.G.
4. Ankle swing velocity
5. Knee swing velocity
6. Braking time
7. Braking time %

Take – off (propulsion phase)

1. Horizontal velocity of C.G.
2. Vertical velocity of C.G.
3. Height of C.G.
4. Ankle swing velocity
5. Knee swing velocity
6. Take-off distance
7. Propulsion time
8. Propulsion time %

9. Contact time
10. Take-off angle

Flight

1. Flight time
2. Height of C.G. above the hurdle
3. Maximal velocity over the hurdle
4. Body inclination angle over hurdle
5. Knee angle above hurdle

Landing (braking phase)

1. Horizontal velocity of C.G.
2. Vertical velocity of C.G.
3. Height of C.G.
4. Ankle swing velocity
5. Knee swing velocity
6. Landing distance
7. Landing angle
8. Braking time
9. Braking time %

Landing (propulsion phase)

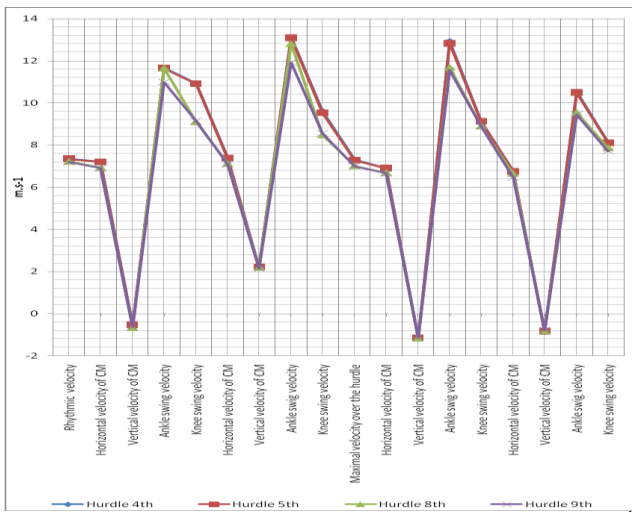
1. Horizontal velocity of C.G.
2. Vertical velocity of C.G.
3. Knee swing velocity
4. Ankle swing velocity
5. Height of C.G.
6. Propulsion time
7. Propulsion time %
8. Contact time

## 7. Results

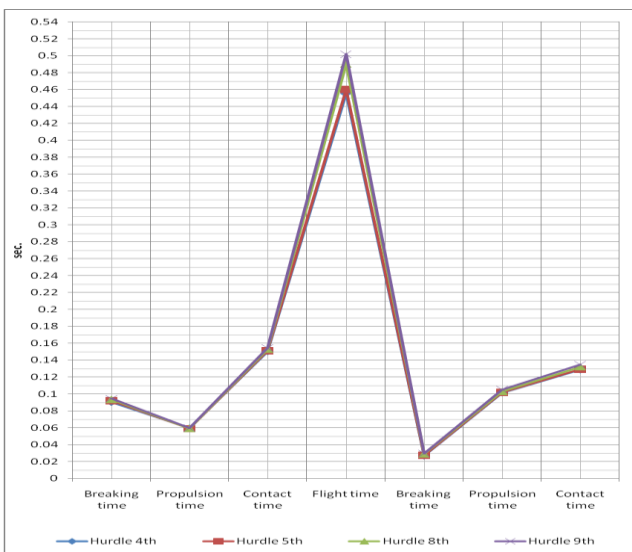
The statistical data show the relationship among the hurdles on following selected kinematical parameters during the hurdle clearance technique in 110m race. Researcher find out that there were coefficient of correlation among 4<sup>th</sup>, 5<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> hurdles during the take-off phase on selected parameters i.e. Rhythmic velocity(4<sup>th</sup> and 8<sup>th</sup>), braking phase: Vertical velocity of C.G.(8<sup>th</sup> and 9<sup>th</sup>), Height of C.G. (4<sup>th</sup> and 9<sup>th</sup>), Ankle swing velocity (8<sup>th</sup> and 9<sup>th</sup>), Braking time(4<sup>th</sup> and 9<sup>th</sup>), Braking time %(4<sup>th</sup> and 5<sup>th</sup>, 5<sup>th</sup> and 8<sup>th</sup>, 5<sup>th</sup> and 9<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup>) propulsion phase: Horizontal velocity of C.G. (8<sup>th</sup> and 9<sup>th</sup>), Vertical velocity of C.G. (4<sup>th</sup> and 5<sup>th</sup>), Height of C.G. (5<sup>th</sup> and 8<sup>th</sup>), Take-off distance (4<sup>th</sup> and 5<sup>th</sup>, 4<sup>th</sup> and 9<sup>th</sup>, 5<sup>th</sup> and 9<sup>th</sup>), Propulsion time (8<sup>th</sup> and 9<sup>th</sup>), Propulsion time % (4<sup>th</sup> and 8<sup>th</sup>, 5<sup>th</sup> and 8<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup>), Contact time(4<sup>th</sup> and 8<sup>th</sup>, 4<sup>th</sup> and 9<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup>), Take off angle(4<sup>th</sup> and 9<sup>th</sup>, 5<sup>th</sup> and 9<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup>) are significant at .05 level. There was no relation among the hurdles on the following parameters i.e. braking phase: Horizontal velocity of C.G., Knee swing velocity propulsion phase: Ankle swing velocity, Knee swing velocity.

During the flight phase there were correlation among the 4<sup>th</sup>, 5<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> hurdle on the following parameters i.e. Flight time (4<sup>th</sup> and 8<sup>th</sup>, 4<sup>th</sup> and 9<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup>), Height of C.G. above the hurdle (5<sup>th</sup> and 9<sup>th</sup>), Body inclination angle above hurdle (4<sup>th</sup> and 5<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup>), Knee angle above hurdle (4<sup>th</sup> and 8<sup>th</sup>) are significant at .05 level. There was no significant relation among the Maximal velocity over the hurdle on any hurdle.

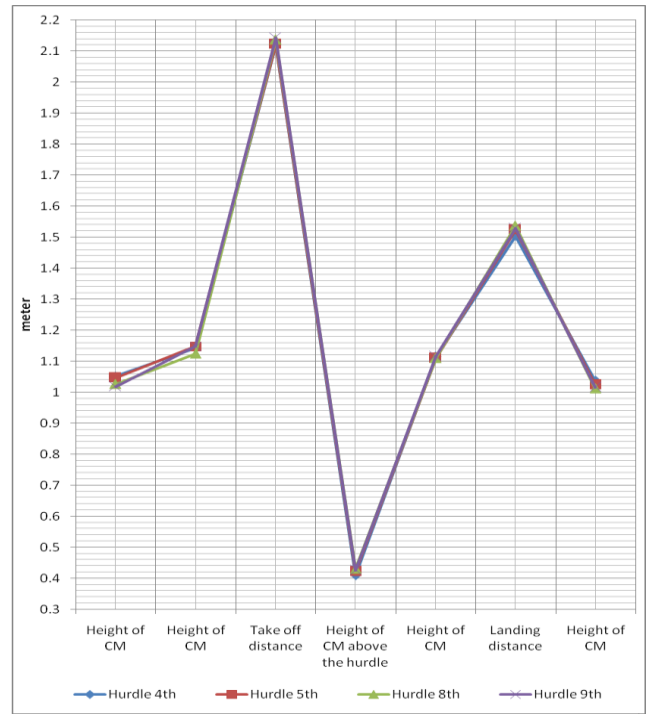
There were coefficient of correlation among the 4<sup>th</sup>, 5<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> hurdle during the landing phase of hurdle clearance on following parameters i.e. braking phase: Horizontal velocity of C.G.(5<sup>th</sup> and 8<sup>th</sup>), Height of C.G. (5<sup>th</sup> and 8<sup>th</sup>), Ankle swing velocity (4<sup>th</sup> and 5<sup>th</sup>), Knee swing velocity (5<sup>th</sup> and 8<sup>th</sup>), Landing distance (4<sup>th</sup> and 9<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup>), Landing angle(4<sup>th</sup> and 8<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup>), Braking time(4<sup>th</sup> and 8<sup>th</sup>), Braking time %(5<sup>th</sup> and 8<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup>) propulsion phase: Vertical velocity of C.G. (5<sup>th</sup> and 8<sup>th</sup>), Height of C.G. (4<sup>th</sup> and 8<sup>th</sup>, 4<sup>th</sup> and 9<sup>th</sup>, 5<sup>th</sup> and 8<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup>), Ankle swing velocity (8<sup>th</sup> and 9<sup>th</sup>), Knee swing velocity (4<sup>th</sup> and 9<sup>th</sup>, 5<sup>th</sup> and 8<sup>th</sup>), Propulsion time % (4<sup>th</sup> and 8<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup>), Contact time (5<sup>th</sup> and 8<sup>th</sup>, 5<sup>th</sup> and 9<sup>th</sup>) are significant at .05 level. There was no significant relation among the hurdles on the following parameters braking phase: Vertical velocity of C.G., propulsion phase: Horizontal velocity of C.G., Propulsion time.



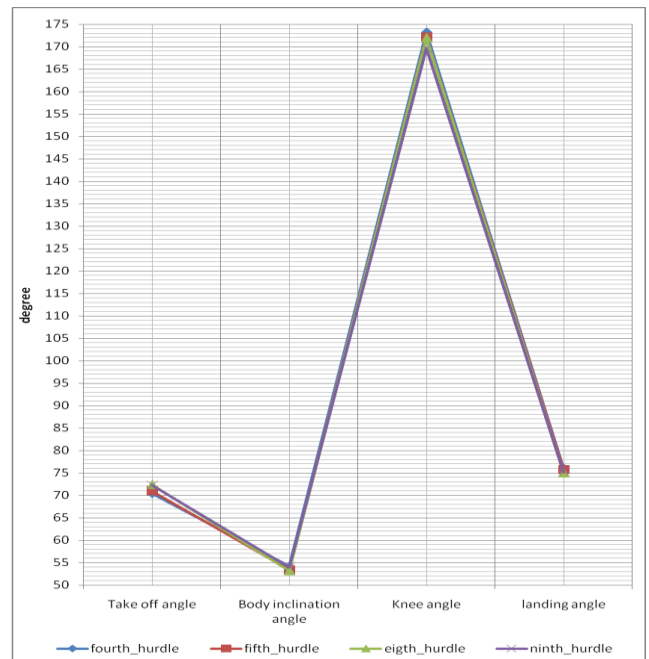
**Graph 1** Graphical representation of relationship among 4<sup>th</sup>, 5<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> hurdle on rhythmic velocity, horizontal velocity of C.G. and vertical velocity of C.G., ankle swing velocity and knee swing velocity at take-off, flight and landing.



**Graph 2** Graphical representation of relationship among 4<sup>th</sup>, 5<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> hurdle on braking time and propulsion time at take-off and landing, contact time and flight time.



**Graph 3** Graphical representation of relationship among 4<sup>th</sup>, 5<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> hurdle on distance, center of gravity at braking and propulsion at take-off and landing.



**Graph 4** Graphical representation of relationship among 4<sup>th</sup>, 5<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> hurdle on take-off angle, body inclination angle, knee angle and landing angle

## 8. Discussion of Finding

The results of study shown that some of the selected biomechanical parameters have significantly relationship among the hurdle i.e. rhythmic velocity among 4<sup>th</sup> and 8<sup>th</sup> hurdle, during the takeoff phase vertical velocity of C.G among 8<sup>th</sup> and 9<sup>th</sup> hurdle, height of C.G among 4<sup>th</sup> and 9<sup>th</sup> hurdle, ankle swing velocity among 8<sup>th</sup> and 9<sup>th</sup> hurdle, braking time among 4<sup>th</sup> and 9<sup>th</sup> hurdle study by Kazuhito Shibayama et. al.(2011) proved hurdler with smaller

horizontal velocity of CG during hurdling had large braking time, braking time percentage among 4<sup>th</sup> and 5<sup>th</sup> hurdle, horizontal velocity of C.G at propulsion phase among 8<sup>th</sup> and 9<sup>th</sup> hurdle, vertical velocity of C.G among 4<sup>th</sup> and 5<sup>th</sup> hurdle, height of C.G among 5<sup>th</sup> and 8<sup>th</sup>, takeoff distance among 4<sup>th</sup> and 5<sup>th</sup>, 4<sup>th</sup> and 9<sup>th</sup>, 5<sup>th</sup> and 9<sup>th</sup> hurdle, propulsion time among 8<sup>th</sup> and 9<sup>th</sup> hurdle, propulsion time percentage among 4<sup>th</sup> and 8<sup>th</sup>, 5<sup>th</sup> and 9<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> hurdle, contact time among 4<sup>th</sup> and 8<sup>th</sup>, 4<sup>th</sup> and 9<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> hurdle and take off angle 4<sup>th</sup> and 9<sup>th</sup>, 5<sup>th</sup> and 9<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> hurdle. There was some parameters have no significant relation among the hurdles i.e. horizontal velocity of C.G at braking of take and knee swing velocity, ankle and knee swing velocity at propulsion phase. Ricardo ferraz et al.2012 showed significant decrease in ball velocity on kicking after one round of fatigue circuit. In the study there was significant relation in 4<sup>th</sup> and 8<sup>th</sup> hurdle in rhythmic velocity that showed Subject able to maintain the speed for long time during the 110m race. Apart from the rhythmic velocity other parameters related with velocity have higher significance relation among the hurdles that showed in performance, physical fitness make him able to perform similar technique over the selected hurdles. Technical parameters of technique like braking time percentage, takeoff distance, propulsion time, contact time and take off angle was significantly related among the all selected hurdles that showed the impact of physical fitness over the performance.

During the flight phase study shown all of the biomechanical parameters have significant relation among the hurdle i.e. flight time among 4<sup>th</sup> and 8<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> hurdle, a study by rolf Graubner 2011 showed different flight time over the all hurdles by top three athletes in 2009 IAAF championship. Height of C.G among 5<sup>th</sup> and 9<sup>th</sup> hurdle, body inclination angle among 4<sup>th</sup> and 5<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> hurdle, knee angle among 4<sup>th</sup> and 8<sup>th</sup> hurdle during the performance. Subject maintained the same performance over the different hurdles during the flight phase also that showed the impact of fitness level on technique.

In landing phase study shown some of the biomechanical parameters have significant relation among the selected hurdle i.e. horizontal velocity at braking phase among 5<sup>th</sup> and 8<sup>th</sup> hurdle supported by Aki I. T. Salo & Simon Scarborough (2006) showed further signs of potential tiredness in the clearances of the ninth hurdle and these changes in technique varied among the athletes, height of C.G 5<sup>th</sup> and 8<sup>th</sup>, ankle swing velocity among 4<sup>th</sup> and 5<sup>th</sup> hurdle, knee swing velocity among 5<sup>th</sup> and 9<sup>th</sup> hurdle, landing distance among 4<sup>th</sup> and 9<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> hurdle, landing angle among 4<sup>th</sup> and 8<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> hurdle, braking time among 4<sup>th</sup> and 8<sup>th</sup> hurdle, braking time percentage among 4<sup>th</sup> and 8<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> hurdle, during the propulsion phase vertical velocity of C.G among 4<sup>th</sup> and 8<sup>th</sup>, 5<sup>th</sup> and 8<sup>th</sup> hurdle, height of C.G among 4<sup>th</sup> and 8<sup>th</sup>, 4<sup>th</sup> and 9<sup>th</sup>, 5<sup>th</sup> and 8<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> hurdle, ankle swing velocity among 5<sup>th</sup> and 9<sup>th</sup> hurdle, knee swing velocity among 4<sup>th</sup> and 9<sup>th</sup>, 5<sup>th</sup> and 8<sup>th</sup> hurdle, propulsion time percentage among 4<sup>th</sup> and 8<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> hurdle, contact time among 5<sup>th</sup> and 8<sup>th</sup>, 5<sup>th</sup> and 9<sup>th</sup> hurdle. There was no significant relation among the horizontal and vertical velocity of C.G at propulsion phase of landing. In his performance most of the biomechanical parameters have relation among all four hurdles at landing distance, landing

ankle, vertical velocity of C.G in propulsion, height of C.G.

## 9. Conclusion

Researcher found there was no relation among the selected parameters on all four hurdles (4<sup>th</sup>, 5<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup>) in subject performance. A studies by Doherty (1953), Hoke(1943), McFarlane(1988), Otrubiannikow & Razumowski(1988), Webster(1929) supported the study that physical factor are complementary to technical factors in hurdle clearance technique. A study by Aki I. T. Salo & Simon Scarborough (2006) all athletes showed signs of potential tiredness in the clearances of the ninth hurdle these changes in technique varied among the athletes. The study showed there was similarity over the non velocity parameters among the selected hurdles that was supported by wen (2005) model of hurdles that generalize the model of hurdle clearance on non velocity parameters and proved that with the improvement of physical fitness relationship among the hurdles increased over the selected parameters that was supported by Aki I. T. Salo & Simon Scarborough (2006) in his study. Study concluded it was hard to create single biomechanical model on all selected parameters of study, that applicable to all hurdles of 110m race. Biomechanical model can be possible on non velocity based parameters of study applicable to all hurdle of 110m race.

## 10. Future Scope

The study will help the coaches to understand the impact of fatigue over the technique during the performance. It will also help the coaches in the preparation of training program for the athletes. It will be helpful in creating a general model of hurdle clearance technique for the assistance of young hurdlers.

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XXVIII International Symposium of Biomechanics in  
Sports July 2010

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