CHAPTER- V
SUMMARY, CONCLUSIONS AND RECOMMENDATION

Summary

The statement of the problem was stated as “Kinematical Analysis of Sprinting Performance at Varied Angles of Block in Athletics”.

The following objectives were set for the present study. First objective of the study was to kinematically analyze sprinting performance at varied angles of block in athletics. Second objective of the study was to compare the set position at varied angles of block in athletics. Third objective of the study was to find out relationship between dependent variable (sprinting performance) and independent variables (selected linear & angular kinematical variables) of varied angles of block in Athletics. Fourth objective was to determine the key components of set position at varied angles of block in athletics.

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Eight male (National / Inter university level) sprinters of Sub Centre Sports Authority of India, Lucknow and Banaras Hindu University Varanasi (who had been participating regularly) were selected and their age ranged between 17 to 30 year. The purpose of the study was explained to the subjects and requested to sprint in their best effort during each attempt.

The following Anthropometrical and kinematic (Linear and Angular) variables were selected for the purpose of this study:-

**Anthropometrical Variables:** Age, Height, Weight, Hand Length, Lower Arm Length, Upper Arm Length, Lower Leg Length, Upper Leg Length and Foot Length. **Linear Kinematical Variables:** Height of centre of gravity of the body at set position. First step length, first stride length and Speed of the subject.

**Angular Kinematical Variables:** Ankle Joint (Angle of left & Right ankle joint), Knee joint (Angle of left & Right knee joint), Hip joint (Angle of left & Right hip joint), Shoulder joint (Angle of left & Right shoulder joint), Elbow joint (Angle of left & Right
elbow joint), Wrist joint (Angle of left & Right wrist joint), Angle of trunk inclination and Angle of Head Inclination.

Criterion Measures adopted for the study were as follows: Age of subject was measured by Chronological Age in year, Height of the subject was measured by Anthropometric Rod in meter, Weight of the subject was measured by Weighing Machine in kilogram, Height of centre of gravity in set position at varied angles of block in athletics was measured by Silicon Coach Pro-7 Motion Analysis Software /Kinovea Experimental version 0.8.25 in centimetre, Speed of subject was measured by Manually in meter/second, and Angle of angular kinematical variables in set position at varied angles of block in athletics was measured by Silicon Coach Pro-7 Motion Analysis Software in degree.

Silicon coach pro-7 motion analysis software was use for kinematical analysis of sprinting performance at varied angles of block in athletics. The centre of gravity of the subject at the time of set position at varied angles of block in athletics was measured by segmentation method as suggested by Games G. Hay was recorded.

The following statistical technique was employed: to kinematically analyse set position at varied angles of block in athletics to, descriptive statistic was used. To compare the different set position at varied angles of block in athletics, analysis of variance (Anova) was used. To find out correlation between dependent variable (30 m performance) and independent variables (selected linear & angular kinematical variables) at varied angles of block in athletics, Pearson correlation was used. To find out regression equation between dependent variable (30 meter performance) and independent variables (selected linear & angular kinematical variables) at varied angles of block in athletics, step wise method was used. The level of significance was set at 0.05. The data was analysed by applying spss20-version.
Conclusions

On the basis of the findings of the study, the following conclusions are drawn:

1. Mean and Standard deviation, scores of Anthropometry variables age in year height in meter, weight in kilogram, Upper Arm, Lower arm, hand length upper leg, lower leg, foot length in centimeter during varied angle of block in athletics have been found as follow: Age of the subjects (22 ± 1.60), Height of the subjects (1.70 ± 0.59), Weight of subjects (64.75 ± 7.16), Upper arm of the subjects (31.87 ± 2.10), Lower arm of the subjects (26.50 ± 2.00), Hand length of the subjects (20 ± 1.06), Upper leg of the subjects (48.18 ± 4.88), Lower leg of the subjects (41.87 ± 2.29), Foot length of the subjects (26 ± 1.01) respectively.

2. Mean and standard deviation, scores of angular kinematics variables at 45/45 block angle in athletics have been found as follow: Left Ankle Angle (97.37 ± 6.27), Right Ankle Angle (110.25 ± 9.28), Left Knee Angle (97.625 ± 7.52), Right Knee Angle (133.50 ± 4.30), Left Hip Angle (45.625 ± 5.069), Right Hip Angle (43.25 ± 9.617), Left Shoulder Angle (100.25 ± 10.88), Right Shoulder Angle (122.00 ± 13.80), Left Elbow Angle (166.37 ± 13.46), Right Elbow Angle (178.87 ± 9.23), Left Wrist Angle (175.00 ± 16.40), Right Wrist Angle (191.25 ± 16.01), Trunk Inclination Angle (39.25 ± 5.444) and Head Inclination Angle (45.37 ± 5.31) respectively.

3. Mean and standard deviation, scores of angular kinematics variables at 45/60 block angle in athletics have been found as follow: Left Ankle Angle (97.50 ± 7.70), Right Ankle Angle (126.62 ± 11.31), Left Knee Angle (100.37 ± 8.314), Right Knee Angle (129.62 ± 9.89), Left Hip Angle (42.75 ± 5.62), Right Hip Angle (35.50 ± 7.09), Left Shoulder Angle (104 ± 9.73), Right Shoulder Angle (125 ± 8.92), Left Elbow Angle (168.87 ± 6.66), Right Elbow Angle (165.25 ± 10.37), Left Wrist Angle (189.125 ± 10.999), Right Wrist Angle (148.25 ± 9.76), Trunk Inclination Angle (31.87 ± 6.95), Head Inclination Angle (40.12 ± 10.94) respectively.

4. Mean and standard deviation, scores of angular kinematics variables at 60/75 block angle in athletics have been found as follow: Left Ankle Angle (106 ± 10.75), Right Ankle Angle (119.75 ± 13.95), Left Knee Angle (102.87 ± 6.03), Right Knee Angle (131 ± 18.87), Left Hip Angle (42.87 ± 8.07), Right Hip Angle (39 ± 7.07), Left
Shoulder Angle (104.37 ± 12.56), Right Shoulder Angle (131.75 ± 13.27), Left Elbow Angle (173.25 ± 9.48), Right Elbow Angle (166.25 ± 13.31), Left Wrist Angle (173.12 ± 8.42), Right Wrist Angle (171 ± 31.07), Trunk Inclination Angle (34.75 ± 8.64), Head Inclination Angle (48.62 ± 8.36) respectively.

5. Mean and standard deviation, scores of angular kinematics variables in 75/90 block angle in athletics have been found as follow: Left Ankle Angle (114.875 ± 22.956), Right Ankle Angle (128.625 ± 20.346), Left Knee Angle (101.50 ± 9.039), Right Knee Angle (131 ± 11.032), Left Hip Angle (41.75 ± 4.832), Right Hip Angle (41.125 ± 10.709), Left Shoulder Angle (103.125 ± 10.278), Right Shoulder Angle (127.50 ± 6.37), Left Elbow Angle (169.50 ± 11.36), Right Elbow Angle (166.50 ± 20.31), Left Wrist Angle (178 ± 13.88), Right Wrist Angle (160.63 ± 24.54), Trunk Inclination Angle (32.38 ± 6.05), Head Inclination Angle (41.5 ± 9.76) respectively.

6. Mean, standard deviation, scores of Linear kinematics variables First Step Length and First Stride Length in meter Center of Gravity in Centimeter Performance in M/Sec at 45/45 Angle of Block in Athletics have been found as follow: First step Length (1.4063 ± .2705), First Stride Length (2.531 ± .4295), Center of Gravity (66.58 ± 6.425), 30 M Performance (4.145 ± .1539) respectively.

7. Mean, Standard deviation, scores of Linear kinematics variables First Step Length and First Stride Length in meter Center of Gravity in Centimeter Performance in M/Sec at 45/60 Angle of Block in Athletics have been found as follow: First step Length (1.463 ± 1.811), First Stride Length (2.581 ± .3162), Center of Gravity (66.78 ± 8.216), 30 M Performance (4.146 ± .3834), respectively.

8. Mean, Standard deviation, scores of Linear kinematics variables First Step Length and First Stride Length in meter Center of Gravity in Centimeter Performance in M/Sec at 60/75 Angle of Block in Athletics have been found as follow: First step Length (1.3113 ± .16287), First Stride Length (2.3775 ± .22372), Center of Gravity (67.256 ± 5.995), 30 M Performance (4.1700 ± .21876), respectively.

9. Mean, Standard deviation, scores of Linear kinematics variables First Step Length and First Stride Length in meter Center of Gravity in Centimeter Performance in M/Sec at 75/90 Angle of Block in Athletics have been found as follow: First step Length (1.46 ± .2593), First Stride Length (2.447 ± .2620), Center of Gravity (65.997 ± 5.164), 30 M Performance (4.198 ± .210), respectively.
10. Insignificant difference was found at varied angle of block in athletics in relation to centre of gravity, as obtained F-ratio was (0.051), which was less than the tabulated value of (2.95), at 0.05 level with (3, 28) degree of freedom.

11. Insignificant difference was found at varied angle of block in athletics in relation to First step length, as obtained F-ratio was (.808), which was less than the tabulated value of (2.95), at 0.05 level with (3, 28) degree of freedom.

12. Insignificant difference was found at varied angle of block in athletics in relation to First stride length, as obtained F-ratio was (.645), which was less than the tabulated value of (2.95), at 0.05 level with (3, 28) degree of freedom.

13. Insignificant difference was found at varied angle of block in athletics in relation to 30 meter performance, as obtained F-ratio was (.972), which was less than the tabulated value of (2.95), at 0.05 level with (3, 28) degree of freedom.

14. Insignificant difference was found at varied angle of block in athletics in relation to Right Ankle angle, as obtained F-ratio was (2.651), which was less than the tabulated value of (2.95), at 0.05 level with (3, 28) degree of freedom.

15. Significant difference was found at varied angle of block in athletics in relation to Left Ankle angle, as obtained F-ratio was (3.039), which was higher than the tabulated value of (2.95), at 0.05 level with (3, 28) degree of freedom. Since the one way analysis of variance was found significant in relation to Left Ankle, the LSD test was applied to find out the differences of the paired means among varied angle of block in athletics.

16. Insignificant difference was found at varied angle of block in athletics in relation to Right Knee angle, as obtained F-ratio was (0.140), which was less than the tabulated value of (2.95), at 0.05 level with (3, 28) degree of freedom.

17. Insignificant difference was found at varied angle of block in athletics in relation to Left Knee angle, as obtained F-ratio was (0.651), which was less than the tabulated value of (2.95), at 0.05 level with (3, 28) degree of freedom.

18. Insignificant difference was found at varied angle of block in athletics in relation to Right Hip angle, as obtained F-ratio was (1.137), which was less than the tabulated value of (2.95), at 0.05 level with (3, 28) degree of freedom.
19. Insignificant difference was found at varied angle of block in athletics in relation to Left Hip angle, as obtained F-ratio was (0.605), which was less than the tabulated value of (2.95), at 0.05 level with (3, 28) degree of freedom.

20. Insignificant difference was found at varied angle of block in athletics in relation to Right Shoulder angle, as obtained F-ratio was (1.118), which was less than the tabulated value of (2.95), at 0.05 level with (3, 28) degree of freedom.

21. Insignificant difference was found at varied angle of block in athletics in relation to Left Shoulder angle, as obtained F-ratio was (0.234), which was less than the tabulated value of (2.95), at 0.05 level with (3, 28) degree of freedom.

22. Insignificant difference was found at varied angle of block in athletics in relation to Right Elbow angle, as obtained F-ratio was (1.494), which was less than the tabulated value of (2.95), at 0.05 level with (3, 28) degree of freedom.

23. Insignificant difference was found at varied angle of block in athletics in relation to Left Elbow angle, as obtained F-ratio was (0.581), which was less than the tabulated value of (2.95), at 0.05 level with (3, 28) degree of freedom.

24. Insignificant difference was found at varied angle of block in athletics in relation to Right wrist angle, as obtained F-ratio was (2.275), which was less than the tabulated value of (2.95), at 0.05 level with (3, 28) degree of freedom.

25. Insignificant difference was found at varied angle of block in athletics in relation to Left wrist angle, as obtained F-ratio was (2.511), which was less than the tabulated value of (2.95), at 0.05 level with (3, 28) degree of freedom.

26. Insignificant difference was found at varied angle of block in athletics in relation to Trunk inclination, as obtained F-ratio was (1.916), which was less than the tabulated value of (2.95), at 0.05 level with (3, 28) degree of freedom.

27. Insignificant difference was found at varied angle of block in athletics in relation to Head inclination, as obtained F-ratio was (1.516), which was less than the tabulated value of (2.95), at 0.05 level with (3, 28) degree of freedom.

28. Insignificant relationship was found of Anthropometry variables with 30 Meter performance at 45/45 angle of block in athletics.

29. Insignificant relationship was found of Anthropometry Variables with 30 Meter performance at 45/60 angle of block in athletics.

30. Insignificant relationship was found of Anthropometry Variables with 30 Meter performance at 60/75 angle of block in athletics.
31. Insignificant relationship was found of Anthropometry Variables with 30 Meter performance at 75/90 angle of block in athletics.

32. Insignificant relationship was found of Angular Kinematical Variables with 30 Meter performance at 45/45 angle of block in athletics.

33. Significant relationship was found of Angular Kinematical Variables with 30 Meter performance at 45/60 angle of block in athletics. The obtained values of “r” in case of Right ankle angle (-.731) was higher than tabulated value of “r” (0.707).

34. Insignificant relationship was found of Angular Kinematical variables with 30 Meter performance at 60/75 angle of block in athletics.

35. Insignificant relationship was found of Angular Kinematical variables with 30 Meter performance at 75/90 angle of block in athletics.

36. Insignificant relationship was found of Linear Kinematical variables with 30 Meter performance at 45/45 angle of block in athletics.

37. Insignificant relationship was found of Linear Kinematical variables with 30 Meter performance at 45/60 angle of block in athletics.

38. Insignificant relationship was found of Linear Kinematical variables with 30 Meter performance at 60/75 angle of block in athletics.

39. Insignificant relationship was found of Linear Kinematical variables with 30 Meter performance at 75/90 angle of block in athletics.

40. The regression equation for angular kinematical variable i.e Right Ankle Angle with 30 meter performance at 45/60 degree block in athletics that is quite reliable as the determined value of $R^2$ is (.534). At the same time the regression coefficients in this model (I) is sedentary significant and therefore it may be interpreted that the variable selected in model (I) viz; Right Ankle Angle is quite valid in estimating the 30 Mt. Performance on set position at 45/60 degree of block in athletics.

41. Block angles influence the initial acceleration of the sprinters.

42. Best combination of Block Angle is very important to yield maximum acceleration of athletes. Thus the research scholar through present study found that the 45/60 degree of angle is suggested to be the best for getting optimum stride length at the initial phase after ejecting from the starting block.

43. Front Block Angle allows the athlete to acquire a conducive body alignment at the time of leaving the block.
44. Front Block Angle plays more determining role than Rear Block with regard to the initial acceleration of the athlete.

45. Lower Block Angle allows the highest possible force to be produced for the longest practicable time. Therefore it facilitates the athlete in producing the greatest impulse and leaving the blocks with the highest velocity.

46. Only single combination of block setting not necessarily always will yield the best result.

47. Different combination will necessarily always not be the determining factor for multiform acceleration ability.

48. Movement from the Starting Block in the sprint start must not only be fast and forceful but should permit the sprinter to rapidly take up a mechanically efficient running position.

49. Performance in the 30 m sprint is influenced by a multitude of factors including starting strategy, stride length, stride frequency, physiological demands, biomechanics, neural influences, muscle composition, anthropometrics, and track and environmental conditions.

50. The sprint start, the accelerative phase of the race, depends greatly on muscular power. Three considerations of the sprint start are reaction time (time to initiate response to the sound of the starting gun), movement time (onset of response until end of movement) and response time.

51. Maximal velocity running is a result of stride length and stride frequency. While stride length can be greatly limited by an individual’s size and joint flexibility, stride frequency can be affected by muscle composition, neuromuscular development, and training.

52. 100 m sprint world record times have progressed drastically; there is limited evidence for how technology has contributed to such improvement. As such, human physiology and physique combine to be the most influential determinants of improved sprint performance.
Recommendations

In the light of the conclusions drawn; the following recommendations are made:

1. Similar studies may be conducted on male players of different games.

2. A comparative study can be conducted between male and female.

3. A more comprehensive study can be conducted on large samples.

4. Similar studies may be conducted on female subjects.

5. The similar study may be conducted on other regions of India with different age groups.

6. Studies may be carried out in other sprinting events also.

7. The coaches and physical educationist may use this reference while imparting coaching to athletes.

8. The finding of the study may be helpful for talent identification.