Relationship of Selected Kinematic Variables with the Performance of Forward Salto Skill on Floor Exercise in Artistic Gymnastics

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Abstract – Introduction: A kinematic assessment is providing information on the relationship of parts of the body to each other. This is useful in measuring joint angles during complex movement and has provided the basis of understanding functional activities comes from kinematic assessments. Purpose: The purpose of this study was to find out the relationship of selected angular & linear kinematic variables with the performance of forward salto technique on floor exercise in artistic gymnastics. Method/Procedure: In the Present study total thirty four male gymnasts (19 to 25 years of age) who had participated in the international and senior national gymnastics tournament were selected as subjects for this study. Purposive sampling technique was used for choosing highly skilled gymnast. Forward salto technique was divided into three phases such as takeoff phase, flight phase and landing phase. The kinematic variables were consisted of selected angular & linear kinematic variables. For the kinematic analysis High speed videography technique was employed. The data were recorded from both planes i.e. sagittal plane and frontal plane. Each subject was given five trials and the best trial was used for analysis. The silicon coach pro 7 and kinovea software were used for analyzing the data. Segmentation method was employed in order to assess to the center of gravity. The relationship of selected angular & linear kinematic variables with the performance of forward somersault on floor exercise in artistic gymnastics was obtained by employing the Spearman Rank Correlation method and the alpha level was set at 0.05 level of significance. Results & Conclusion: The findings of the Spearman rank correlation shows significant relationship between the angle at Left hip joint & Right hip joint at the time of take off phase, negative significant relationship of forward salto performance with hip joint left, hip joint right, and shoulder joint left, elbow joint left and right at the time of flight phase respectively, at the time of Landing phase shows that there exists a significant relationship between forward salto performance and Knee (left), knee joint (Right), hip joint (left) & hip joint (right) as the values were found higher than the tabulated value at .05 level of significance, linear kinematic variable clearly indicates that there exists a significant relationship between Forward salto performance and Total flight duration, Maximum height, Center of gravity at flight time, were found higher than the tabulated value at .05 level of significance. Whereas other selected angular & linear kinematic variables does not show any significant relationship with at the Takeoff Phase, Flight Phase & landing phase because the calculated value was found less than the table value at 0.05 level of significance.

Keywords: Forward Salto, Kinematic Variables (Angular & Linear), Rank Correlation.

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Introduction: "If you don't know why you've failed how can you improve?

"If you don't know why you've succeeded it must be an accident."

Lord Sebastian Coe.

We are in the age of science and technology. Man cannot live without the aid of science. Sports and physical activity has been considered an integral part of human life since its inception. The athletes of today, whether recreational or elite, run and swim faster, throw farther, and jump higher than their competitors from the past. These improvements have been attributed to several factors related to smarter nutrition; a greater understanding of biomechanics of sport movement, better training techniques, advances in psychological support, and improvements in coaching education. Biomechanics is most useful in improving performance in sports or activities where technique is the dominant factor rather than physical structure or physiological capacity. Gymnastics combines strength, flexibility, grace and discipline. Gymnastics is practiced by males and females on both competitive and recreational levels. Artistic gymnastics, each group doing different events men compete on floor exercise pommel horse

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still rings table vault parallel bar, high bar while women compete on vault, uneven bar, beam and floor. Floor exercise is composed of tumbling movements, balances, handstands and gymnastics movements. The mechanical principles play an important role related with performance. The knowledge and the principle of biomechanics play a key role to teach and trained the accurate skill to the gymnast. In gymnastics every skill is having biomechanical orientation. In this context the mechanical principles play an important role in performance. Objectives/Purpose: To determine the mechanics of the forward salto technique on floor exercise in artistic gymnastics. The purpose of this study was to find out the relationship of selected angular & linear kinematic variables with the performance of forward salto technique on floor exercise in artistic gymnastics.

METHOD/PROCEDURE:

Thirty four male gymnasts (19 to 25 years of age) who had participated in the international and senior national gymnastics tournament were selected as subjects for this study. They were from different states Punjab, Haryana, Delhi, Uttar Pradesh, Bengal, Gujarat, Maharashtra, and Orissa. Purposive sampling technique was used for choosing highly skilled gymnast. Forward salto technique was divided into three phases such as takeoff phase, flight phase and landing phase. The kinematic variables were consisted of selected angular kinematic variables i.e. the measurements of angles at various joints of ankle joints (right & left), knee joints (right & left), hip joints (right & left), shoulder joints (right & left), and elbow joints (right & left), & body angle at the time of takeoff phase. The linear kinematical variables selected were: Height of CG at the time of takeoff phase, Height of CG at the time of flight phase, Height of CG at the time of landing phase, Takeoff to landing displacement, Total flight duration, Total takeoff duration, Maximum height, Takeoff speed, Speed of hip joint at takeoff, Speed of hip joint at flight and Speed of hip joint at landing. For the kinematic analysis of forward salto technique on floor exercise in artistic gymnastics, High speed videography technique was employed. The two Casio Exilim EX-F1 high speed cameras and one sonv HD camera were used for this purpose. The data were recorded from both planes i.e. sagittal plane and frontal plane. Each subject was given five trials and the best trial was used for analysis. The performances of subjects were evaluated by the qualified judges on the basis of execution of the skill evaluated by six judges. The silicon coach pro 7 and kinovea software were used for analyzing the data. Segmentation method was employed in order to assess to the center of gravity. The relationship of selected angular & linear kinematic variables with the performance of forward somersault on floor exercise in artistic gymnastics was obtained by employing the Spearman Rank Correlation method and the alpha level was set at 0.05 level of significance.



Fig-1 Angular Kinematic Variables at the Time Take off Phase



Fig-2 Angular Kinematic Variables at the Time Flight Phase



Fig-3 Angular Kinematic Variables at the Time Landing Phase



Fig-4Linear Kinematic Variables (Path) at the Fight Phase



Fig-5 Linear Kinematic Variables at the Landing Phase



Fig-6 Linear Kinematic Variables Horizontal Distance

ANALYSIS OF DATA AND RESULTS OF THE STUDY:

The scores pertaining to each selected angular and linear kinematic variables have been presented in table 1 to 4.

Table-1: Descriptive Statistics of Angular & linearKinematic Variables of Forward Salto at the Time of
Takeoff Phase

Phases	Descriptive	Ankle	Ankle	Knee	Knee	Hip	Hip	Shldr.	Shldr.	Elbow	Elbow	Body
	Statistics	Joint	Joint	Joint	Joint	Joint	Joint	Joint	Joint	Joint	Joint	Angle
		Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	T.off
Takeoff	Mean	138.05	138.00	174.05	173.85	141.3	141.35	127.94	128.05	164.79	164.97	80.17
	S.D.	6.84	6.73	3.41	3.41	12.47	12.47	13.29	13.10	10.79	10.88	3.37
Flight	Mean	109.70	109.64	71.35	71.23	61.88	61.79	25.94	25.76	140.76	140.50	
	S.D.	12.69	12.89	9.987	10.11	12.84	12.76	8.20	8.18	17.07	17.63	
Landing	Mean	124.58	124.41	128.26	128.23	157.5	157.44	53.55	53.76	125.76	125.82	
	S.D.	11.88	11.60	8.77	8.80	15.28	14.93	28.53	28.44	39.05	39.15	

Table: 2 Descriptive Statistics of Linear Kinematic Variables of Forward Salto

Descriptive Statistics	Dst.	Tm	T.T.	HT. Max.	CG TT	CG FP	CG FP AR	CG LP	TS F	TS H	FSH	LSH
Mean	1.48	.625	.125	1.77	102.67	158.5	160.9	89.90	4.29	4.48	5.01	4.59
S.D.	.288	.055	.010	.130	4.387	9.197	9.74	3.189	.689	.6003	.5379	1.051

DST: Displacement from takeoff to landing (Cm.) TM: Time taken during complete movement

TT: Take off time (Sec.)

HT MAX: Height maximum from ground (Cm.)

CG TT: Center of gravity at takeoff phase

CG FP: Center of gravity at flight phase

CG FPA: Centre of gravity at flight after rotation phase

CG LP: Centre of gravity at flight after landing phase

TSF: Take off Speed (Ankle)

TSH: Speed of hip joint at Take off

FSH: Speed of hip joint at Flight

LSH: Speed of hip joint at Landing

Table- 3: Relationship of Selected Angular KinematicVariables with the Performance of Forward Salto at the
Time of Takeoff, Flight & Landing Phase.

Independent Variables	Correlation coefficient (Takeoff)	Correlation coefficient (Flight)	Correlation coefficient (Landing)
Ankle Joint (left)	0.217	0.081	0.271
Ankle joint (Right)	0.208	0.083	0.315
knee joint (left)	0.095	-0.161	0.486*
Knee Joint (Right)	0.104	-0.132	0.506*
Hip joint (left)	0.492*	-0.411*	0.537*
Hip joint (Right)	0.492*	-0.396*	0.546*
Shoulder joint (Left)	-0.319	-0.354*	0.311
Shoulder joint (right)	-0.337	-0.322	0.323
Elbow joint (Left)	-0.224	-0.486*	0.137
Elbow joint (Right)	-0.223	-0.513*	0.141
Takeoff Body Angle	0.227		

* Significant at .05 level, ρ . 05 (32) = 0.350

Takeoff Phase: The finding of the table showed that significant relationship between the angle at Left hip joint & Right hip joint at the time of take off phase of forward salto on floor in artistic gymnastic (0.492),(0.492) respectively were obtained. Whereas other selected angular kinematic variables does not show any significant relationship with at the time of takeoff phase because the calculated value was found less than the table value at 0.05 level of significance.

Flight Phase showed that negative significant relationship of forward salto performance with hip joint left, hip joint right, shoulder joint left, elbow joint left and

right at the time of flight phase (-0.411), (-0.396), (-0.394), (-0.486), (-0.513) respectively were obtained.

Landing Phase shows that there exists a significant relationship between forward salto performance and Knee (left), knee joint (Right), hip joint (left) & hip joint (right) as the values (0.486), (0.506), (0.537) and (0.546) were found higher than the tabulated value at .05 level of significance

On the other hand, there exists an insignificant relationship between forward salto performance and ankle (Left & right), shoulders (Left & Right), & Elbow Joint (Left & Right) values were found lower than the tabulated value at 0.05 level of significance.

Table- 4: Relationship of Selected Linear Kinematic

 Variables with the Performance of Forward Salto

Coefficient
0.032
0.666*
-0.093
0.592*
0.285
0.539*
0.592*
-0.271
-0.033
-0.174
0.197
0.126

* Significant at .05 level ρ .05 (32) = 0.350

Table - 4 clearly indicates that there exists a significant relationship between Forward salto performance and Total Flight Duration, Maximum height, Center of gravity at flight time, Center of gravity at flight time(after rotation) values were found higher than the tabulated value at .05 level of significance.

On the other hand, there exists an insignificant relationship forward salto performance and other linear kinematic variable were found lower than the tabulated value at .05 level of significance

CONCLUSION & DISCUSSION:

Based on the analysis and within the limitations of present study, it was concluded that:

1. The angle of left hip joint & right hip joint had positive relationship at the time of take off phase of forward salto on floor in artistic gymnastics with performance. Statistically findings were indicating that only in hip joint angle significant relationship with the performance was found. Whereas other selected angular kinematic variable does not show any significant relationship with the performance at the time of takeoff phase. Statistically results were insignificant but mechanically insignificant angular kinematics variables were contributing for performance because without contribution of these variables gymnast cannot perform forward salto. Other selected angular & linear kinematics variable does not show with the performance of forward salto (takeoff) which may be due to the different patterns adopted by the gymnasts during the course (learning) of forward salto. This may not be technically correct.

- 2. The angle of hip joint left, hip joint right, shoulder joint left, elbow joint left and right had negative significant relationship at the time of flight phase of forward salto on floor exercise in artistic gymnastics with performance. On the basis of Qualitative & Quantitative findings of the study it was found that during flight phase all the joints were flexed to the minimal possible angle. This was such because closing body to minimal possible area during the tuck position helps in maximizing the speed of rotation. Thus, the rotation is performed in minimal possible time and with utmost precision.
- 3. Results revealed that the angle of left knee joint & right knee, left hip joint, right hip joint were significant relationship with forward salto performance at the time of landing phase on floor exercise in artistic gymnastics. On the basis of qualitative and quantitative findings of the study it was found that as the head completes the rotation and passes the vertical line, the body was stretched in anticipation of the landing. At the time that the body came in contact with the mat, however, the knees and the hips was slightly bent to ensure a softer landing..
- 4. In liner kinematic variable takeoff duration, height of centre of gravity at the time of takeoff, takeoff speed of hip joint and takeoff speed was found insignificant relationship with the performance at the time of takeoff phase of front salto in artistic gymnastics.
- 5. Result shows significant relationship with total flight duration, maximum height centre of gravity at flight time, centre of gravity with forward salto performance on floor exercise in artistic gymnastics

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