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KINEMATIC ANALYSIS OF OLYMPIC GOLD MEDALIST DISCUS THROWER

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Abstract:

Discus Throw is the game of distance, which is largely depended upon the technical and physical qualities of an athlete. The purpose of the present study is to discuss the various kinematical research reports concerning discuss throw. The present study discussed the various kinematic parameters of discus throwers based on the qualitative meta-analysis of findings of other researchers. Twenty gold medalists' Olympic throwers 10 male and 10 female were taken into account for the study. Correlation matrix was calculated for height, weight BMI and Gold medal winning distance and conclude that for men BMI were significantly related with weight of the subjects and in case of female throwing performance were significantly related with height.

Keywords: *Kinematic Analysis, Discus Throw and Olympic Gold Medallist.*

Introduction:

Kinematic analysis is the way to describe the movement in order to assess speed, height and distance of a moving object. Thus, position, velocity, and acceleration are the important components in kinematic analysis. Observing the projectile properties of a jumper or studying the performance of swimmers are the examples of linear kinematic analysis (1). A throwing movement's purpose in sports is generally distance, accuracy, or a combination of the two. As the field throwing events have no accuracy limits, the longest distance of the throw is the primary aim. The overall performance of an athlete in such sports is regularly evaluated, and their training progress is tracked, in terms of clearly visible physiological aspects including launch velocity, angle, peak of release, and speed (2). The discus throw also appears frequently in Greek mythology, as a method of homicide in the cases of Hyacinth, Crocus, Phocus, and Acrisius, and as a listed event in Patroclus' funeral games (3). The early discs were supposedly heavier than today's competition discus since they were constructed of

unwrought bronze and iron (4). In discus throw participants use rotational process to project a disc and compete depending on distance travelled. Excluding the effect of the wind, the flight distance is determined by the starting projection velocity, the angle of projection, and the height of projection at release (5).

The purpose of the study was to analyse the height, weight, BMI with throwing performance of ten summer Olympic gold medallist discuss throwers (both men and women) and general meta-analytical discussion of kinematic concept associate with it.

Origin: The discus was invented by the Greeks and became a competitive event. Eventually the Greeks began using bronze and iron to make the round, plate-shaped implements (6). The men's discus is now spherical, with a diameter of 219 mm (8.6 inches) and a thickness of 44 mm (1.75 inches) and weighing 2kgs and in case of women's the weight is 1 kg (2 pounds 3.2 ounces) and measuring 180 mm (7.1 inches) (2).

Process of Discus Throw:

Discus was first included in the modern Olympic games in 1896 for men and 1928 for women. The men's record is 69.89 meters (Athens, 2004) and women's record is 72.30 meters (Seoul, 1988) (7).

The fundamental movement is a forehanded sidearm action. The discus is spun from the throwing hand's index or middle finger. When viewed from above, the disc rotates clockwise and anticlockwise for right-handed throwers and left-handed throwers respectively. The distance of the discus is governed by the trajectory the thrower imparts as well as the aerodynamic behaviour of the discus, in addition to attaining maximum momentum in the discus during throwing. Throws into a mild headwind acquire the most distance. A faster-spinning discus also provides more gyroscopic stability (3).

The discus throwing method consists of the preliminary swings, preparation, entrance, airborne position, transition, delivery, and recovery (8) (Figure – 1).

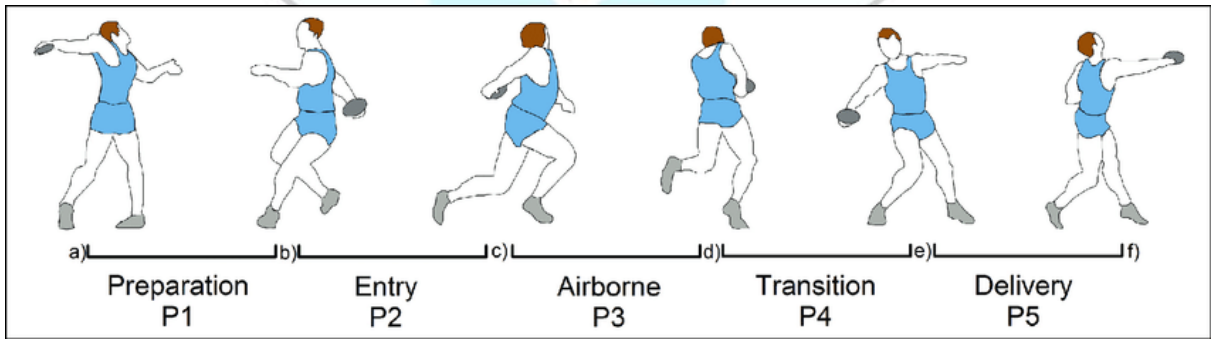

Fig.-1 Phases of discus Throw

For a right-handed athlete, the preceding stages (P1 to P5) and essential transition factors (a to f) are adopted from Yu et al (9).

P1) Preparation, a two-phase support phase that begins with the discus changing direction at the conclusion of its backward swing and ends with the right foot breaking contact.

P2) entry, which consists of a single support phase that ends with the left foot losing contact.

P3) Airborne, with the proper foot re-contacting on the stop;

P4) Transition, a single support phase that terminates with the touchdown of the left foot;

P5) Delivery, which begins with a double support phase and concludes with the discus being released. a) The begin of the discus trajectory, b) the proper foot takeoff, c) the left foot takeoff, and d) the right foot launch e) left foot landing, and f) discus release (10).

The discus technique is split into four steps: double and single help starting phases, supportless phase, single and double support delivery phases, and supportless phase (11). considering the fact that release velocity, height and angle are regularly mentioned because the maximum applicable biomechanical metrics in important track and field competition studies (12-14).

Background and Reviews:

Throwing a discus needs physical abilities and technical qualities to make complicated actions at fast speeds in a small space. The action of the discus throw is typically broken down into five sequential stages for analysis. Each step has a varied impact on the ultimate throwing performance, although all are heavily impacted by lower-limb activity. The impact of the upper limbs on discus thrower performance has only been studied through the study of body coordination during the throw, demonstrating that the lowest variability in the arm-shoulder kinematic pattern generally leads to the best performance (10).

The various Kinematical study in discus throw is listed in Table-1.

SL No.	Name and Year	Topic of the Paper	Result	Conclusions
1.	Roger.M.. Bartlett (1992) (8)	The biomechanics of the discus throw: A review	An evaluation of the experimental procedures and the report of the experimental errors, especially for film studies, are included for discus throwers.	They concluded that there's currently inadequate relevant and reliable biomechanical facts to answer among the important questions about discus throwing approach, and some future research guidelines are advised to conquer those
2.	Cliff Frohlich (1981) (15)	Aerodynamic effects on discus flight	The effects on distance thrown caused by changes in wind velocity, altitude, air temperature, gravity, and release velocity were studied	Some sample results show that the disc can travel: (i) 8.2 m further against a 10 m/s wind than with such a wind; (ii) 0.13 m further at 0 °C than at +40 °C; (iii) 0.19 m further without wind at the Rome, Italy altitude than at

				the Mexico City, Mexico altitude; and (v) 0.34 m further at the equator than at the poles.
3	Túlio Banja (1981) (16)	Kinematics and aerodynamics parameters on paralympic discus throw	Thirty-one throws made by an athlete who was for three times Paralympics champion. For the kinematical analysis were used the 3D and 2D kinemetric method. The images were recorded by two high-speed cameras (120Hz) and a low speed one (60Hz). Aerodynamic analysis was calculated by drag and lift forces during flight phase.	The results showed good correlations of drag and lift forces with flight distance, and no relation to wind and position to the range.
4	Kazuya et. al. (2015) (17)	Optimization of flight distance and robustness in the discus	There are ten control and design components, which include variables such as the talent of the thrower and the design of the equipment.	The talent of the thrower and the inherent qualities of the equipment are among the ten control and design factors examined. It was discovered that flying distance and resilience had a trade-off.
5.	Oleg Nemtsev (2011) (8)	Comparison of kinematic characteristics between standing and rotating discus throw.	In a standing throw, the discus drops lower and has a lower release angle, according to 3-D analysis.	Differences in delivery method between standing and rotating discus throwing may be used as a training tool. Discus throwing kinematics performed by highly skilled discus throwers with more steady technique are to be studied in the coming years
6.	Vassilios Panoutsakopoulos, Iraklis A. Kollias (2012) (19)	Temporal analysis of elite men's discus throwing technique	The results showed that there was no significant correlation ($p > 0.05$) between the mean official throw distance (63.04 ± 6.09 m) and the duration of the discus throw or the duration of each technical phase. Most throwers spent a greater percentage of their swing (transition, serve, and release phases) in a single than a double.	It appears that a short transition phase duration, combined with lower values of the ratio of time spent on the starting lap compared to time spent on the handover lap, might be favourable for achieving a longer take-off distance.
7.	Robert j. Gregor, William C. Whiting, (20)	Kinematic Analysis of Olympic Discus Throwers	Little difference was observed between men and women in terms of release angle and speed, and the results were comparable to previous studies of elite performers. But there were differences observed in foot	The men seemed to have a more vertical thrust when they were lifted off the ground before release and, even given their greater body height, release the disc with a higher arm

			position at release and height at release between men and women.	position. The three-dimensional nature of this event precludes any further interpretation at this stage In terms of release speed and angle, the results show minimal differences between men and women.
8.	Steve Leigh, Hui Liu, Mont Hubbard, Bing Yu (2010) (21)	Individualized optimal release angles in discus throwing	The results of this study show that the optimal launch angle for the discus throw is specific to the thrower. Clearance angles used by elite discus players in competition are not necessarily optimal for all discus players, or even themselves. The results of this study provide important information for understanding biomechanics of discus throwing techniques.	Launch speed and aerodynamic distance is closely related to the disc launch angle Throw. Relationships between release rates and launch angle, between aerodynamic distance and the launch angle significantly affects the optimal launch angle The longest official distance

Kinematic Analysis:

Individual athletes' total performance in discus throw is frequently evaluated, and their training progress is monitored, in terms of easily apparent physiological features such as launch velocity, angle, peak of release, and speed (2)**.** The study of Gregor et al. (1985), that the primary differences at release were in foot position and discus relative height. Men appeared to have stronger vertical thrust before to release, pushing them off the ground (14). Roger M. Bartlett (1992) undertook a review of quantitative data on discus biomechanics, his findings are contrasted with video discus tosses with measured release circumstances. It is suggested that there is now insufficient relevant biomechanical evidence to resolve many of the crucial concerns (10). The discus is a very aerodynamic weapon (22) to determine the flight path of a discus when it is thrown, it is essential to know the aerodynamic forces acting on it (23). This means that, under certain conditions, the distance thrown might be greatly increased or decreased in comparison to what would be anticipated in a vacuum or in still air. The official discus throw distance is determined by speed, height, and release angle. During the throwing operation, each athlete's technique affects the release characteristics, therefore the most successful discus throw method is to maximize the speed of release while also optimizing the angle and height of release. Many previous studies on the discus throw have looked at the basic biomechanical factors of release during the delivery phase, such as speed, angle, and height of release (24-26). Despite the fact that these characteristics directly impact the anticipated distance of the throw, they provide little information on the stages preceding up to

release. Variations in relative wind speed, primarily, and secondarily, the angle of release, the velocity of release, the attack angle, the inclination angle, the tilt angle, the rotation of the discus around its short and long axes, the effective mass of the discus, and its moment of inertia, all contribute to the favorable conditions. The discus is affected by gravity as well as the aerodynamic forces of lift, drag, and pitching moment during its flight. The other component, lift, is the product of the same elements but has its own dimensionless coefficient that assesses the implement's ability to create force parallel to the velocity vector (27).

Result and Discussion:

In this study, 10 summer Olympic gold medallists in the discus thrower category, both men and women, were chosen and their biomechanical data of height, weight, and throwing distance were collected in order to compute a correlational link between these parameters. Table no-2 for men and Table No-3 for women represent the biomechanical data.

Table - 2. Criterion parameters of Olympic Gold Medalist (Men), (3)

SL NO.	Name	Country	Olympic games	Throwing distance(meters)	Height(meters)	Weight (k.g)
1	Viktor Rashchupkin	Soviet Union	1980 Moscow	66.64	1.88	107
2	Rolf Danneberg	West Germany	1984 Los Angeles	66.6	1.98	125
3	Jürgen Schult	East Germany	1988 Seoul	68.82	1.93	110
4	Romas Ubartas	Lithuania	1992 Barcelona	65.12	2.03	120
5	Lars Riedel	Germany	1996 Atlanta	69.4	1.99	110
6	Virgilijus Alekna	Lithuania	2004 Athens	69.89	2.02	130
7	Gerd Kanter	Estonia	2008 Beijing	68.82	1.96	127
8	Robert Harting	Germany	2012 London	68.27	2.01	126
9	Christoph Harting	Germany	2016 Rio de Janeiro	68.37	2.07	120
10	Daniel Ståhl	Sweden	2020 Tokyo	68.9	2	155

Table -3. Olympic gold medalist (women), (3)

Sl no.	Name	Country	Olympic games	Throwing distance (meters)	Height (meters)	Weight (k.g)
1	Evelin Schlaak	East Germany	1976 Montreal	69	1.79	84
2	Evelin Jahl	East Germany	1980 Moscow	69.96	1.79	84

3	Ria Stalman	Netherlands	1984 Los Angeles	65.36	1.79	82
4	Martina Hellmann	East Germany	1988 Seoul	72.3	1.78	85
5	Ilke Wyludda	Germany	1996 Atlanta	69.66	1.84	95
6	Ellina Zvereva	Belarus	2000 Sydney	68.4	1.83	100
7	Natalya Sadova	Russia	2004 Athens	67.02	1.8	95
8	Stephanie Brown Trafton	United States	2008 Beijing	64.74	1.93	95
9	Sandra Perković	Croatia	2016 Rio de Janeiro	69.21	1.83	85
10	Valarie Allman	United States	2020 Tokyo	68.98	1.83	70

Table-4. Represents the corelation matrix of men

	WEIGHT	HEIGHT	PERFORMANCE
HEIGHT	0.393894724		
PERFORMANCE	0.236700557	0.108038918	
BMI	0.884966076 *	-0.077699991	0.187424543

*Significant at .05 level (Critical Value .444)

Table-5. Represents the corelation matrix of women

	WEIGHT	HEIGHT	PERFORMANCE
HEIGHT	0.350475754		
PERFORMANCE	-0.231685105	-0.524920067*	
BMI	0.88013489*	-0.136013483	0.018125251

*Significant at .05 level (Critical Value .444)

From table 4 and 5 indicates that BMI of the discus throwers were highly related with weight, actually high value of the BMI depends upon higher weight and or lower height of the subject. Further, from table 5 we can observe that discuss throwing performance for women were significantly related with height, ideally a discus thrower is gifted with athletic ability which may be evident as they excel in other sports. Height is also of great benefit. Height provides two indispensable qualities. First, long arms provide long levers. The range of the height of the male and female discuss Olympic gold medallist were 1.88-2.07 meters and 1.79-1.93 meters respectively which clearly indicated that a good height is require for good performance in discuss throw.

Conclusion:

Discus was one of five events of the ancient Olympic Games' pentathlon, and it was well-known during the time of Greek poet Homer, who mentions it in both the Iliad and the Odyssey. The present study discussed the various kinematic parameters of discus throwers based on the qualitative meta-analysis of findings of other researchers. Twenty gold medalists' Olympic throwers 10 male

and 10 female were taken into account for the study. BMI were significantly related with weight of the subjects and in case of female throwing performance were significantly related with height. Lack of availability of data of all the athletes' other parameters were the limitations of the study for the study.

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