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Sagittal Plane Release Parameters of the Javelin Throwing: A Review

P. C. Thotawaththa[1], A.W.S. Chandana[1]
[1]*Department of Sport Sciences & Physical Education, Sabaragamuwa University of Sri Lanka & P. O. Box 02, Belihuloya 70140, Sri Lanka.*

Abstract:
Background*: The aim of the study was to conduct a comprehensive analysis of scientific studies on maximizing competitive javelin throwing performance according to the field of study. Release parameters on the sagittal plane are the subject of this research. As a result, detailed articles on javelin throwing, published in English in peer-reviewed journals and conference papers, were evaluated.*
Materials and Methods*: This systematic review of those leaflets includes more than 30 screened articles. Twelve articles have been published since 1985. The publications identify the biomechanical analysis of javelin throwing at the IAAF World Athletics Championships, the kinetic analysis of the World University Championships, and the biomechanical field of javelin throwing.*
Results*: The throwing phase was the most in-depth aspect of the study. No research has yet been done on javelin throwers without biomechanical consideration. A collaborative study among sports disciplines is needed to identify methods to minimize injuries and improve the performance of licensed javelin throwers.*
Conclusion: *According to our research, the release velocity is the most essential element that helps to achieve the highest release velocity from the body angle in order to achieve the highest performance of the spear. Performance detection depends on the release angle, however it fluctuates according to external conditions (Wind, Aerodynamic).*
Key Word: *Biomechanical Factors, Javelin Throw, Performance, Release Parameters*

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I. Introduction

Javelin throwing is a throwing sport that is included in track and field competitions. To reach long throwing distance, javelin throwers are asked to change not only the internal element such as the spear release speed, but also external factors such as wind speed and direction. The biomechanics of javelin throwing have been primarily tested over a period of time, and the majority of the study has focused on the values of certain release parameters [25,8]. For any given thrower, there will be a set of release parameters that will produce the greatest range. Biomechanical studies of javelin throws have mainly focused on **release parameters, such as releasing velocity, release angle, attitude angle, attack angle, and release height** [5,17,10,16]. These studies found that a high release velocity was the key factor for achieving top performance. Moreover, Whiting, Gregor, & Halushka (1991) have investigated the movement characteristics that are necessary to optimize the approach, transition, release, and flight phases. Murakami et al., (2006) have also confirmed the importance of release velocity and identified specific throwing movement characteristics that enabled finalists at world championships to achieve higher velocities, compared to other competitors.

The previous studies on biomechanical aspects of javelin throwing performance [1,3,8,16,28,29] are based on data collected during competition. These records include several elements that determine the final performance, including the release velocity, the angles associated with the spear, and the release height. There are some attempts to account for the contribution of body parts that contribute to the terms of release [1,2,29]. Only the horizontal plane is focused on the vertical plane. This article focuses on the kinetic analysis of spear throwing speeds supported by previous publications and research. It is important for sports coaches to understand the differences in technical implementation between their athletes and those close to the theoretical technical pattern. Most of the biomechanical research focuses on the kinetic parameters of elite throwers [15,17,19]. Systematic review technology is based on previously published standards. Critically evaluates research using secondary data collection and systematic procedures. Full data on javelin throwing are included in the full articles. Potentially eligible studies published between 1985-2018. Identify through searches of the Google Scholar, Science hub, Science Direct, Web of Science using the keywords "Javelin throw", "Biomechanics". Consider the data World championships, Olympic, Asian and University athletes. Also, we get other Biomechanics published articles related to Javelin throwing.

The articles in Retrieve were examined in three stages (title, summary, and full text). Additional leaflets were found by searching the reference section of each item found. Articles are categorized based on their subject matter (Releasing Parameters, joint, and segment angle of the movement of release also taking about approach velocity before release javelin) Subcategories, Release angle, Initial velocity, attitude angle, attack angle in a javelin thrower

Five studies published only in summary, one published in Spain, one published in Asia, one published in New Zealand, and two studies presented in reserve data from the IAAF were excluded after a screening of more than 30 identities (International association of athletics federation. All published in international journals, and International Conferences were included in the systematic review. The authors reported that players' biomechanics factors that they were being evaluated increased their performance and perceived level of effort, Javelin throw has different phases such as approach run, 5 step rhythm (transition), the power position, the throw, recovery. Most authors analysis the throwing phase biomechanics factors and then taking other phases. Most important part in javelin throw all are thinking just before releasing. 1 author focused the approach phase. In this study has focused on sagittal plane releasing parameters.

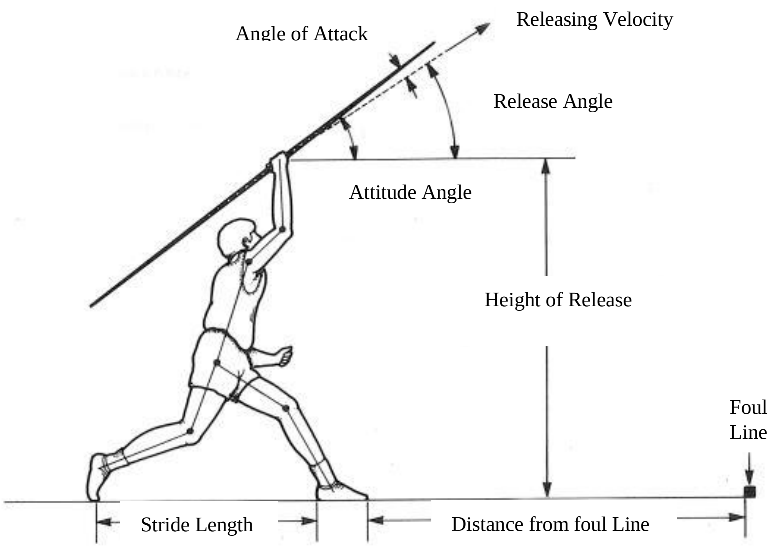

Figure No 1: Javelin Throw Sagittal Plane Releasing Parameters

Many terms related to the release of the spear and its subsequent flight are shown in Fig.1. The angle measured from the horizontal to the long axis of the spear at any given time is called the angle of view. On landing, this should be negative to record a reasonable throw. The angle measured from the horizontal to the velocity vector at the center of the spear mass relative to the ground is called the release angle. The angle of attack is the angle measured from the long axis of the spear to the relative wind vector, the velocity of the wind and the vector variation of the spear. The angle of attack is the angle between the long axis of the spear and the velocity vector of the spear relative to the ground only when there is no wind, and then the angle of attack is equal to the difference between the angle of release and the angle of release. In most film studies on javelin throwing, the angle of the pronounced attack ignores the effect of wind speed [3].

II. Results

Releasing Parameters

Summary and Limitations

For the majority of the observed release parameters, Table 1 presents a summary of values obtained prior to 1985. Due to a lack of data on wind speeds and tar release speeds, cross-study comparisons are limited. Variations in reported numbers also challenge the real-time estimation of the release [16]. Thards (1983) was the first to measure the tar speed of a spear's release, and Hubbard (1984a) stated that this parameter was as essential as the throwing distance of a spear. Torad's (1983, 1985) pitch rates, on the other hand, appear to be questionable. For example, one throw was recorded at a pitch ratio of 53 s, where simulation studies [10] show that the spear traveled only 54 m, as opposed to 88.5 m reported by Torrad (1983). Torrads' anomalies between Petronoff's two throws can be explained by the relatively high bitumen velocity, which results in a reduction of approximately 6 m in spite of the high release velocity. A similar measurement study of the anomaly pitch ratio among other throws is explained, e.g. Despite changes in release speed and angle within the experimental error limits of Miller and Munro (1983a) and Bartlett (1982a, b), two of Ershov's recorded by Terrods (1978a) varied by 6 m. Therefore, not significant. Studies by Miller and Munro (1983) and Komi and Mero (1985) show the importance of wind speed, having a tailwind here can explain high release angles and negative 'uncorrected' angles of attack was reported. Rich et al. (1985a, b) was one of the few studies that include Creed. Wind speeds and day-to-day fluctuations in activity throughout a 15-month study period may have contributed to some of the significant standard deviations recorded, as well as the likelihood of a broad range between throwers. Rich et al. (1985b), like Kunz and Kaufman (1980), discovered slightly higher standard deviations for their athletes due to a large disparity in throwing skill. Unfortunately, due to the lack of release speed in Kunz & Kaufman's experiments (1980) and the lack of remote data in Bartlett's (1982a) investigations, it is difficult to compare this study with any other study in the literature using decathletes [3].

Table no 1: Summary table kinematics variables before 1895

Author (s)	Population	Release Speed (ms^{-1})	Release Angle (Degree)	Release Angle of Attack (Degrees)	Release Attitude Angle (Degrees)
Terauds (1983)	Petranoff (M)	29.33	31	10.5	41
	Petranoff	30.17	31	7.5	38
	Michel (M)	27.52	33	0.5	31
Terauds (1978a)	Nemeth (M)	30.9	35	6	41
	Nemeth	30.9	34.5	9	43.5
	Nemeth	29.2	32	8	40
	Meglea (M)	28.6	37.5	2.5	40
	Meglea	29.4	36	2	38
	Ershov (M)	27.9	35	0	35
	Ershov	26.8	35	1.5	36.5
	Ershov	27	34.5	0.5	35
	Olsen (M)	28.1	28.5	3.5	32
Terauds (1978b)b	Colsen (M)	27.26	31.6	16.2	-
	Lusis (M)	27.63	32.6	5.1	-
	Luke (M)	27.53	33.8	3.8	-
	Zirnis (M)	26.91	35.4	2.4	-
	Colsen	27.88	34.5	15	-
Komi and Mero d (1985)	Harkonen (M)	29.12	42	-13	29
	Ottley (M)	29.09	26	15	51
	Elberbrink (M)	26.6	34	4	38
	Petranoff (M)	26.07	38	12	50
	Atwood (M)	25.78	42	-6	36
	Sanderson (W)	2073	33	2	35
	Lilak (W)	23.62	38	0	38
	Whitbread (W)	21.08	47	0	47
	Laaksalo (W)	21.86	46	-6	38
	Sulinski (W)	22.62	40	-8	32
	Rivers (W)	21.26	47	-12	35
Bartlett d (1983a)	N=1W	16.37	40.8	-1	39.8
Gregor and Pink (1985)	Petranoff (M)	32.3	32.7	4	36.7
Miller and Munro cdc (1983)	N = 2M	29.3	35.5	-5	30.6
	N = 1M	26	37.7	-2.1	35.6
	N = 1M	26.5	36.1	1.2	37.3
	N = 5M	25.9 (S.D. = 1.0)	40.6 (S.D. = 2.7)	2.4 (S.D. =1.0)	43 (S.D. =3.1)
	N = 2M	25.6	39.6	7	46.6
	N = 4M	27.8 (S.D. = 0.2)	36.7 (S.D. = 1.6)	(-)0.9(S.D. = 2.6)	35.8 (S.D. =4.2)
	N = 6M	27 (S.D. = 1.0)	33.6 (S.D. = 1.5)	6.3 (S.D. = 1.4)	39.8 (S.D. = 1.3)

	N = 6M	25.5 (S.D. = 1.0)	41.3 (S.D. = 1.7)	6.2 (S.D. = 2.1)	47.5 (S.D. =2.5)
Bartlett (1982a)cdc	N = 4D	15.6 (S.D.=0.6)	15.7 (S.D. = 8.7)	26.9 (S.D. = 6.6)	42.5 (S.D. = 4.7)
Bartlett (1982b)cdc	N = 8H	11.6 (S.D.=0.9)	23.1 (S.D.=4.9)	10.6 (S.D.=9.4)	33.7(S.D. = 9.1)
Kunz and Kaufman c (1980)	N = 20De	-	33.1 (S.D. = 2.9)	6.9 (S.D.=4.4)	39.2 (S.D. = 4.5)
	Subject A (M)	-	37	0	37
	Subject A	-	34	4	38
	Subject B (M)	-	38	2	40
Kunz (1980)d	Wolfermann (M)	29.99	38	2	40
	VanWartburg (M)	26.14	37	0	37
	N=8D e	21.24	43	10	33
Ikegami et al. cdc (1981)	N = 7M	24.80 (S.D. = 1.5)	32.9 (S.D. = 1.6)	7.5 (S.D. = 2.7)	-
Rieh et al. e (1985a,b)	N = 28 (W)	22.3 (S.D.=0.9)	32.7 (S.D. = 3.4)	5.9 (S.D. =4.0)	38.6 (S.D.=4.0)
	N=15(M)	29.4 (S.D. = 1.5)	30.3 (S.D.=2.3)	8.2 (S.D. = 2.8)	38.5 (S.D.=4.0)

Release Height (m)	Front Foot to Foul Line (m)	Run up Speed (ms^{-1})	Javelin Spin at release (Hz)	Pitch at release (Degree s^{-1})	Distance Thrown (m)
-	-	-	-	-6	94.62
-	-	-	-	-53	88.48
-	-	-	-	0	92.08
2.05	-	-	-	-	94.58
2.05	-	-	-	-	89.28
1.96	-	-	-	-	83.82
2.18	-	-	-	-	87.16
2.21	-	-	-	-	82.1
1.97	-	-	-	-	83.26
1.96	-	-	-	-	78.32
1.92	-	-	-	-	72.06
1.82	-	-	-	-	87.76
2.01	-	-	22.2	-	mean 80.77
1.86	-	-	23.1	-	for first
1.91	-	-	24	-	four throws
1.68	-	-	19	-	-
1.96	-	-	16	-	86.86
-	2.48	5.57	-	-	86.76
-	3.52	4.65	-	-	85.74
-	2.62	6.1	-	-	83.3
-	4.05	4.74	-	-	78.4
-	3.77	4.91	-	-	78.1
-	2.68	5.17	-	-	69.56
-	2.53	5.61	-	-	69
-	2.4	6.45	-	-	67.14
-	2.83	5.75	-	-	66.4
-	2.08	4.65	-	-	58.38
-	1.46	4.8	-	-	55.88
-	-	4.8	-	-	-
2.09	2.33	-	-	-	99.72

2.06	3.83	-	-	-	8018
1.99	3.85	-	-	-	69.36
2.02	2.75	-	-	-	73.34
2.11	1.76	-	-	-	73.33 (S.D. = 3.19)
1.94	3.18	-	-	-	66.65
2.13	2.31	-	-	-	75.89 (S.D. = 1.82)
2.03	2.4	-	-	-	73.84 (S.D. = 1.63)
2.16	2.23	-	-	-	72.57 (S.D. = 2.59)
-	-	5.2 (S.D.=0.3)	-	-	-
-	-	4.0 (S.D.=0.5)	-	-	-
-	-	-	-	-	54.30 (S.D. = 6.48)
-	-	-	-	-	76.34
-	-	-	-	-	80
-	-	-	-	-	80.76
-	-	6.38	-	-	80.76
-	-	6	-	-	76.34
-	-	5.27	-	-	53.27
-	-	6.25 (S.D. = 0.47)	-	-	59.31 (S.D. = 5.62)
1.85(S.D. = 0.13)	1.94 (S.D. =0.60)	-	-	-	54.2 (S.D. = 3.3)
2.09 (S.D.=0.10)	2.49 (S.D. = 0.32)	-	-	-	84.4 (S.D. = 3.5)

M = Male(s); W=Female(s); D=Decathlete(s); H=Heptathlete(s); [b] data given in feet, converted to meters by the authors; "individual data given; 'extra data provided; 'means only.

Table 2 summarizes the values found for most of the observed release parameters since 1985. The thrower's right foot starts the attacking journey. It is assumed that the horizontal momentum gained when the thrower touches the last left foot will be converted into a combination of vertical and horizontal upper body movement [17], Significant correlations were obtained between the distance thrown and the release angle, attitude angle, attack angle and release height [20]. The results indicated that elite throwers had higher theoretical distances and higher initial velocity of javelin release [21]. A significant positive correlation was observed between the distance thrown and the calculated theoretical distance ($r = 0.909$, $p < 0.001$) [20].

Kinetic variable correlation analysis reveals that the observed variables have a significant number of correlations. Based on the observed kinetic variable correlation analysis, the following conclusion can be drawn: the spear release speed is more critical, and then the front support legs are faster. The findings are encouraging and reasonable, as kinetics can be applied especially in the technical learning process of young throwers and in the development of motor skills related to this sport [26].

The results confirmed the differences in the measured parameters between the two world championships in the men's and women's finals. In males, 60% changes were observed (free velocity, u angle, distribution length, distance to the bad line, duration of impulse flow, duration of release), unlike in females 40% (angle release, u angle, impulse flow, Duration, release time) observed [23].

Table no 2: Summary table kinematics variables after 1895

Author (s)	Population	Release Speed (ms-1)	Release Angle (Degree)	Release Angle of Attack (Degrees)
Murakami et al. (2017)	N=16	23.49 ± 1.79	34.46 ± 2.97	2.77 ± 3.97
Predrag et al. (2013)	N=113	25.02 ± 0.92	39.02 ± 3.57	0.51 ± 1.81
Campos et al. (2002)	N=6	28.91	-	-
	N=8	24.8	-	-
Tauchi et al. (2009)	Pitkamaki	29.9	39.9	5.7
	Thorkilden	29.8	35.9	3.5
	Greer	29.3	35.6	1.5

	Vasilevslis	29.1	33.4	3.7
	Ivanov	28.8	34.3	1.5
	Oosthuizen	28.5	34.6	3.6
	Janik	28.7	32.5	1.7
	Jarvenpaa	28.6	32.2	6
	Martinez	28.5	32.9	4.6
	Arvidsson	28.3	31.9	1.2
	Rags	28.2	38.7	1.8
	Wirkkala	28.2	32.8	9.7
	N=12	28.8 ± 0.6	34.6 ± 2.6	3.7 ± 2.5
Lehmann (2010)	N=11	29	33.5	13.6
Xei et al. (2001)	-	-	-	-
Pavlovic et al. (2020)	A. Thorkilden (NOR)	29.3	37.6	10.5
	G. Martinez (CUB)	29.7	36.5	7.4
	Y. Murakami (JPN)	28.9	31.9	11.6
	V. Vasilevslis (LAT)	29.9	31.3	8.6
	T. Pitkamaki (FIN)	28.9	34.3	13.3
	A. Ruuskanen (FIN)	29	32.6	4.9
	A. Kovals (LAT)	29.4	30	11.5
	M. Frank (GER)	29	34.4	6.6
Antti et al. (1994)	N=11	28.3 ± 0.9	32 ± 4.21	(-1) ± 6
Best et al. (1993)	SB1	30.4	33.5	-2.5
	SB2	29.2	32	-8
	SB4	29.2	32	-5.5
	OC4	29.8	30	-4.5
	NB5	27.6	33	1.5
Morriss et al. (1997)	Zelezny	30.2	40	0
	Backley	30.1	34	-1
	Henry	29.4	38	-6
	Hecht	28.9	40	-6
	Wennlund	29.1	36	-6
	Hill	28.4	39	-2
	Rybin	27.7	42	-4
	Linden	28.1	36	1
	Zelezny	28.3	37	1
	Moruyev	28.1	38	-1
	Raty	28.9	37	-8
	Hakkarainen	28.2	39	-9
Viitasalo et al. (2003)	Thrower A (n=11)	27.9 ± 0.4	34.7 ± 3.3	6.2 ± 4.3
	Thrower B (n=13)	27.3 ± 0.6	34.9 ± 1.9	(-5.0) ± 2.4
	Thrower C (n=15)	26.9 ± 1.0	33.6 ± 1.7	(4.0) ± 3.2
	Thrower D (n=16)	27 ± 0.6	33.8 ± 2.6	2.2 ± 1.8
	Thrower E (n=18)	27.3 ± 0.7	30.8 ± 1.6	4.4 ± 2.7
	Thrower F (n=23)	27.6 ± 0.5	31.9 ± 1.8	(-2.1) ± 2.2
	All Throws (n=155)	27.1 ± 0.7	32.7 ± 2.6	2.3 ± 4.8

Release Attitude Angle (Degrees)	Release Height (m)	Front Foot to Foul Line (m)	Step Length	Distance Thrown (m)
37.42 ± 3.00	1.73 ± 0.16	-	-	76.06 ± 5.62
-	-	-	-	67.27 ± 3.94
-	1.97	-	-	86.45
-	1.8	-	-	68.39
45.6	1.99	-	1.72	90.33
39.4	1.86	-	1.64	88.61
37.1	1.71	-	1.88	86.21
37.1	1.81	-	2.14	85.19
35.9	1.89	-	2.35	85.18
38.2	1.91	-	1.98	84.52
34.2	1.87	-	1.96	83.38
38.3	1.78	-	2	82.1
37.5	2.03	-	1.76	82.03
33	1.99	-	1.72	81.98
40.5	1.96	-	1.72	80.01
42.5	1.84	-	1.72	78.01
38.3 ± 3.5	1.89 ± 0.10	-	1.88 ± 0.22	83.96 ± 3.48
37.1	-	2.75	1.95	82
-	-	-	-	-
37.9	-	2.7	1.75	89.59
40.6	-	3.3	2.02	86.41
34.1	-	2.9	1.75	82.97
35.9	-	1.2	2.09	82.37
42.7	-	3.5	1.93	81.9
32.3	-	2.7	2.16	81.87
35.5	-	3	1.84	81.54
38.3	-	3.2	2.21	81.32
31 ± 6	1.81 ± 0.04	-	1.8 ± 0.1	80.47 ± 4.21
-	1.86	-	-	87.42
-	1.88	-	-	83.22
-	1.86	-	-	81.62
-	1.88	-	-	80.6
-	1.68	-	-	69.4
-	1.81	-	-	89.06
-	2.02	-	-	86.3
-	2.02	-	-	86.08
-	2.13	-	-	83.3
-	1.85	-	-	82.04
-	1.84	-	-	81.06
-	2.06	-	-	79.54
-	1.81	-	-	79.72
-	2.12	-	-	79.58
-	1.85	-	-	79.14

-	2	-	-	78.76
-	2.12	-	-	78.16
-	-	-	-	81.37 ± 1.95
-	-	-	-	79.76 ± 2.83
-	-	-	-	78.13 ± 2.27
-	-	-	-	79.26 ± 2.75
-	-	-	-	79.12 ± 2.82
-	-	-	-	81.61 ± 2.18
-	-	-	-	78.34 ± 2.53
-	-	-	-	79.00 ± 2.91

M = Male(s); W=Female(s); D=Decathlete(s); H=Heptathlete(s); [b] data given in feet, converted to meters by the authors; "individual data given; 'extra data provided; 'means only.

Release Angle

In the XY plane, there was no significant correlation between the release angle and the throw distance, but in the XZ plane there was a strong positive correlation over the athlete over 70 m (r = 0.492, p 0.001) [21]. Yazid's best throw average release angle was 34.9 degrees and Mahuse's was 36.4 degrees. Both of their release angles were less than the average of 38 degree among World Championship athletes. Yasid's best throw was about 3.38 meters behind the line, while Mahoze's javelin was about 1.83 meters behind the line. Yazid's release speed was slightly faster than Mahuse's but his release angle was less than ideal and he was unable to maximize his throw distance [34].

Javelin throwers had a low average emission velocity (28.78 m/s), a high emission angle (38 °) and a small deviation angle at the 1995 World Cup in Gothenburg. As mentioned earlier, first-class Jan Zelezny and an angle of 40 ° at 30.2 m/s showed that the discharge speed is more essential than other throwing problems. Today, even elite javelin throwers aim at a maximum discharge angle of close to 40 °. At the 2009 World Cup in Berlin, the average elimination angle for male finalists was 34 ° (Thorkildsen-37.6 °) and the average exit speed was 30 m/s (Vasilevskis-29.9 m/s). In Daegu, the average discharge angle was 34.6 ° (de Zordo-37.3º) and the average discharge velocity was 28 m/s (de Zordo-29,90 m/s). For higher pitches, the length of the kickback path is 210-250 cm, and the maximum tension time interval is 0.12-0.18 sec. From a resolution of 27 º-40 º, it is consistent with the results of this study [23].

Initial Velocity

Significant positive correlation was observed between the throwing distance and initial velocity of javelin release (r = 0.904; p < 0.001). And significant positive correlation was observed between the throwing distance and theoretical distances. (r = 0.912; p < 0.001) [21]. When these results are applied to the relation between throwing distance and initial velocity of javelin release, we found that the initial velocity of javelin release was equivalent to approximately 26 m/s (throws of 70 m), which is a high initial velocity of javelin release. Moreover, we assumed that the throw distances and the initial velocity of javelin release cross the 45-degree line at the 70 m point [21]. The average release speeds of Mahuse and Yazid were 25.2 m/s and 25.1 m/s respectively. These speeds were relatively slower than those performed by the elite throwers in the 1995 World Championship (28–30 m/s) reported by Morriss et al. (1997). The javelin throwers analyzed in this study were eight male finalists at the 11th IAAF World Championships in Athletics in Helsinki, Finland in August 2005. A significant positive correlation was observed between the initial velocity of the javelin and the distance thrown (r = 0.889, p < 0.001) [20].

Overall throwing capabilities ranged from 45.25 meters to 87.17 meters. Significant positive correlations were observed between the initial velocity and the input velocity (r = 0.657, p <0.001) and between the input velocity and the distribution velocity (r = 0.925, p <0.001). Compared with the OG group (1010.86 ± 3.82 rad / s), the EG group (99.03 ± 2.05 rad / s; p <0.05) showed a significantly lower angular velocity of bending of the supporting leg. The knee extension angular velocities of the support leg were 7.46 ± 2.26 rad/s in the EG group and 10.91 ± 3.30 rad/s in the OG group, which showed a significantly lower angular velocity (p <0.05). The speed of release depends on the quality of the body's kinetic energy transmitted to the hand and thus to the spear. The results show that international level (over 80 meters) throwers are more capable of throwing spears. Release speed has been identified as one of the factors that most distinguishes throwers at different performance levels [7].

With respect to distance, there was a significant positive correlation coefficient between distance and the output velocity; Other release parameters show a significant correlation with distance. Within each component of the release velocity, there was no significant correlation between the distance and horizontal release velocities, which were the highest mean values of the three components, but there was a significant correlation between the distance and vertical release velocities. This result suggested that the vertical release velocity was determined by the level (distance) as a prerequisite for obtaining a horizontal release velocity of 23-24 m/s among elite javelin throwers [27]. The average release speeds of Mahuse and Yazid were 25.2 m/s and 25.1 m/s, respectively. These speeds were relatively slower than those set by the elite throwers at the 1995 World Championships (28-30 m/s) recorded by Morris (1997).

The slower release speeds (around 4 m/s slower) performed by SEA sports throwers are attributed to their shorter throw distances (up to 18 m) compared to their world champions. Yazid's best throw average averaging release angle was 34.9 ^{0} and Mahuse's 36.4 ^{0}. Both of their release angles were smaller than the average of 38 ^{0} World Champions athletes [34]. The average output velocity for male finalists is around 29 m/s, while for females it is 25 m/s, the highest single competitive values recorded (Vasilevskis, Thorkildsen, Martinez, Zordo, Kovals, Abakumova, Nerius, Spotakova, Obergfoll, Molitor) [23].

Attitude Angle & Attack Angle

Although there was no significant correlation between the attitude angle of the XY plane and the throwing distance, a significant negative correlation was observed in the XZ plane over 70 m ($r = 0.470$, $p <0.001$) With respect to the attack angle, there was a significant negative correlation between the attack angle and the throw distance on the XY plane ($r = -0.303$, $p <0.05$), but there was no significant correlation between the athlete at 70 m. ($r = -0.414$, $p < 0.01$). Moreover, a significant negative correlation was observed only in athletes over 70 m in the XZ plane ($r = 0.471$, $p <0.001$) [21].

Releasing Height

Data reveals that international throwers, who have averaged 1.97 m and 1.90 m for each team, throw from a higher position than those at the national level (p: 0.021). Keep in mind that the release height is adjusted to the size of the thrower, so it may be appropriate to apply some corrective action to formalize the results. However, it is true that the release height is determined not only by the size of the thrower, but also by the actions performed throughout the final stage, including the actions of the right and left foot [7]. According to Murakani et al. (2017), Campos et al. (2013), Tauchi et al. (2002), Antti et al. (1994), Best et al. (1993) and morriss et al. (1997) release height has high values. 160 - 2.15 m but some higher values do not show a significant difference between performance and height. But the average release height has the best significant difference shown by these studies.

Joint and Segment Angle of the Movement of Release

At final foot strike the thrower begins the process of transferring momentum from the lower body to the upper body. For a right-handed thrower this is achieved by flexing the hip and extending the knee of the left leg prior to ground contact. This leg is then used as a brace for the upper body to work against at left foot strike. For the transfer of momentum to be most effective it is thought that the athlete should flex the left knee only very slightly between foot strike and release. Indeed, a significant inverse correlation ($r = -0.93$) has been reported between the degree of front leg knee flexion and the distance thrown [17].

Morriss & Bartlett, (1996) found a significant difference between elite throwers and those of lower skill levels in their capacity to achieve this. Accurate values for the elbow angle at final foot strike necessitate a filming protocol that is 3 dimensional in nature. In studies using 3-dimensional filming, the best throwers reportedly achieve values in excess of l50^{0}. Using only the angle of elbow flexion at final foot strike to give an indication of the acceleration path of the javelin can be misleading. Some elite athletes, who arrived at final foot strike with a relatively flexed elbow, have been found to perform a small degree of elbow extension immediately following final foot strike. This may be to enhance the eccentric contraction of the muscles involved in the distribution process prior to concentric contraction. While the position of the bent elbow at the touch of the end foot may limit the thrower's acceleration path, other, more favorable features can balance these disadvantages. Carrying the spear with a slightly bent elbow can optimize the force-to-speed ratio of the working muscles passing through the shoulder and elbow joints [17]. Although significant negative correlations were observed between the distance thrown and both the elbow joint angle ($r = –0.484$, $p < 0.001$) [20]. Although a significant positive correlation was observed between the distance thrown and the forward trunk rotation angle ($r = 0.463$, $p < 0.001$). The distance thrown and the front leg knee joint angle showed a significant positive correlation ($r = 0.310$, $p < 0.05$) [20]. Zheng's first and second steps were 13 ° and 15 °, respectively, and were 6.0 ° and 6.6 ° for the best female athletes in the world, from which we could see a clear gap ($P < 0.01$) with a difference of 7. And 8.4, which show that Zheng's body castor angle was very large when the first and second throw speeds were removed from the spear, resulting in a significantly weaker body support effect and the legs moving very fast. Does, the support foot landing is very large, the landing is large. Therefore, the horizontal speed gained in run-up loss, more which in turn affects the tempo of the throwing pace, as well as the velocity and range of cross steps [14].

Table no 3: Technical Traits of Zhaocun Zheng's Throw Pace

Record (m)	per	Throwing step torso caster angle (^{0})				Left Maximum angle (^{0})	Torso and arms stretch angle (^{0})	Torso force angel (^{0})
		First step	Second step	Third step	Fourth step			
91.36	1	13^0	15^0	24^0	20^0	158^0	90^0	21^0

Table no 4: Technical Traits of World Elite Javelin Athletes' Throw Pace

Record (m)	n	Throwing step torso caster angle (^{0})				Left Maximum angle (^{0})	Torso and arms stretch angle (^{0})	Torso force angel (^{0})
		First step	Second step	Third step	Fourth step			
91.90 ± 5.18	8	6.0±5.53	6.6±5.23	20.2± 7.65	21.0± 6.49	162.5±8.49	90.0±5.55	21.0±6.49

Zhaocun Zheng, a great javelin thrower, has a lower bending angle than the average skilled javelin thrower in the world, which shows that his braces on the left side of his body are not fitted enough to convert his body strength into running. To make the muscles flexible. The speed of the spear during the launch phase is affected by the reduction of muscle contraction and energy transfer [14].

III. Conclusion

We suggest that a high initial javelin velocity can be obtained by converting the rotational velocity of the stem, thereby generating a higher swinging speed. We suggest that a kick movement may be required to maintain a high horizontal velocity in the center of gravity until the moment the final front foot touch occurs, similar to the movements of elite sprinter players [21]. Compared with World Championship throwers, the release speeds of Mahuse and Yazid were much slower, and their release angles were also smaller. To improve in their throw, the speeds of their mass centers should be increased especially at FFS and effectively transferred to the javelin at the delivery (by more rapid deceleration of their mass center velocities at release). Notably, Yazid should try to move his release point forward (closer to the foul line) to reduce the initial distance lost [34]. The results showed that the vertical plane (XY plane) was not significantly connected to the throwing angle of view. Although there is no significant correlation between the release angle and the throw distance in the horizontal plane (XZ plane), the study of the attitude and angle of the attack revealed that both are smaller as the throw distance increases. According to the findings, elite javelin throwers with long throw distances seem to create an ideal javelin angle that reduces the amount of javelin drag at the point of release [21].

Our findings confirm that most important factor for achieving a high performance in the javelin is the release velocity. The characteristics of the throwing movement of the finalists at World Championships that enable them to obtain a higher release velocity than other throwers are as follows:

• They approach with faster velocity and keep the fore knee angle in the extended position during the final phase of throw to change the approach velocity into the forward rotation of trunk

• During the forward rotation of the trunk, they keep their elbow joint angle small and adduction-abduction angle of the shoulder also small to be able to effectively transfer the internal rotation velocity of the shoulder joint to the grip velocity [20].

In track and field sports, javelin throwing is a skill-complex and fast-paced project. Proper javelin throwing skills Athletes are able to unleash the power of the human body in quick running. As a result, it is important to understand that javelin throwing technology is a perfect process in which each component connects and influences the other. Overmuch concentration on a single stage can have a negative impact on the overall process in a variety of ways, which can be detrimental to overall skill performance [14]. Each author focuses on the effect of the release parameter on the maximum distance of the spear. According to some research, the entry velocity and release moment are related, and the momentum of the entry is shifted to the release moment, resulting in the highest possible release velocity for the spear. Although some findings claim that segment angle has little bearing on performance, the majority of case studies reveal that joint angles aid in achieving strong eccentric motion when throwing a javelin.

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