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Diagnosis of the release phase in the discus throw relative to elite throwers' height

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ABSTRACT

The aim of this study was to quantify the correlation between the thrower's height and the release height ratio. Furthermore, an estimated equation was provided for predicting the optimal release height of the discus based on the thrower's height. To achieve these goals, a descriptive approach was applied to a sample of 30 top discus throwers who achieved a horizontal displacement of more than 61 m. The results showed a statistically significant relationship ($p < 0.05$) between the thrower's height and the release height ratio. In addition, an estimated equation was developed for predicting the optimal release height of the discus relative to the thrower's height: release height (m) = -46.121 × thrower height (m) + 175.66. These findings suggest that thrower height plays a meaningful role in determining the optimal release height, providing practical guidance for coaches and athletes to improve discus throw performance.

KEYWORDS

Discus Throw; Release Phase; Height; Elite Throwers; Estimated Equation

1. INTRODUCTION

The discus throw is one of the throwing events in athletics. The technique of this event is characterized by complex movements that perform very quickly in the circle throwing, also includes the movement successive by joints body, which allows the creation of speed can be transferred to the discus (Blazevich, 2010; Saratlija et al., 2013).

In athletics, the main goal of a throwing event (discus throw) is to achieve the longest throwing distance, which is affected by many variables, including anthropometric measurements of the thrower, and kinetic variables: release velocity, angle of release, and height release of discus throw (Maeda et al., 2017). However, discus throw is considered one of the most difficult motor skills, which demands a high level of coordination, speed, and power. In addition, it depends on the thrower's ability to move his body parts in coordinated synchronized movements. The thrower moves in a sequenced rotational movement that occurs while his body is in contact with the ground (single support–double support) or not in contact (flight phase). These variables on the discus throw would be very useful for coaches and athletes. It would provide quantitative data and provide a better understanding of how to optimize the discus technique (Rani & Singh, 2015; Campos et al., 2009).

The human body consists of many segments which move due to muscle contraction, so biomechanical analysis is one of the most important tools that could help us to understand human motion. However, in the field of sports performance, biomechanical analysis is an important tool to evaluate athletic performance and provide coaches and researchers s with useful information which can help them to develop and achieve a high level of performance (Leigh et al., 2008).

Biomechanical analysis has helped to sort and categorize the many information into its main elements, and then to treat them statistically, to summarize them in specific numerical results that can be interpreted, in other words, Where he contributed to the development modern of technological methods, which helped to a large extent in determining the variables affecting the performance of sports skills in general and throw events in particular (Vodickova, 2008).

Studies indicate the importance of the release height of the discus throw, which refers to the vertical displacement between the discus and ground at the release phase moment, where the optimal release height when the discus reaches the thrower's shoulder level, which allowing to create the most considerable velocity of the discus, thus contributing to the most prominent horizontal displacement of the discus (Leigh et al., 2008). Zaras et al. (2021) stated that discus throwers are taller than javelin throwers. Moreover, Maeda et al. (2018) noted that world champions in the discus event release the discus in front of the shoulder to optimize the kinetic chain. Abdel Fattah et al. (2014) reported that the release height constitutes 82% of the thrower’s height, while Abdel-Monsef Aly et al. (2012) indicated that this ratio is 86%. Hamoury & Alhayek (2006) also found a statistically significant correlation between the thrower’s height and the throwing distance in the discus event. Cho et al. (2008) point to the importance of anthropometric measurements and their role in investigation achievements. In addition, the use of modern technical equipment has contributed to the improvement of the training and technical process of throwers, because reliance on the trainer and his experience is often insufficient to identify weaknesses and provide objective feedback (Rani & Singh, 2015).

The description of the elite technique of the thrower gives an insight into the individual models of those throwers to regulate their use for high performance. These models eventually become references that help coaching and athletes achieve maximum mechanical efficiency through interrelationships between the kinetic variables affecting achievement (Campos et al., 2004).

The experience of the coach is often relied upon to determine the optimum height release in the discus throw event, and this reduces the chances of athletic achievements. There is also a low interest among coaches in biomechanics to determine the kinematic variables that affecting in achievement, and this leads to wasting time and effort. The current study aims to quantify the correlation between the thrower's height and the release height, and to identify the optimal release height in the discus throw relative to the thrower's height. This provides coaches with an objective method, steering away from randomness and minimizing trial and error. Such an approach not only saves considerable time and effort in the thrower's preparation but also holds the potential to positively contribute to performance improvement. Moreover, the research seeks to establish a theoretical foundation for coaching, aiming to foster the development of achievements for throwers in this event. It underscores that a coach, despite expertise, cannot made a champion in this event without accurate scientific information about the numerical values of kinematic variables that significantly impact performance and achievement.

2. METHODS

2.1. Participants

The researchers used a descriptive correlational approach on a sample of 30 of the world's best discus throwers who participated in the World Championships and Olympic Games between 1994 and 2014, achieving a horizontal displacement of more than 61 m (mean height 1.95 m, mean mass 119 kg). The focus on this time period is explained by the availability of complete data on the throwers' height, mass, and performance.

2.2. Procedure

To obtain the kinematic variables values and anthropometric measurements of the sample study, the researchers reviewed some of the references and scientific studies, which addressed these variables (Panoutsakopoulos & Kollias, 2012; Leigh, et al., 2008; Ariel et al., 2005; Abdel Fattah et al., 2014). Additionally, the researchers check the homoscedasticity values of the descriptive statistics indicators for the kinematics variables under study (Table 1).

Table 1. Descriptive statistics indicators for the kinematic variables

Kinematic variables	Minimum	Maximum	Mean	SD	Coefficient of Variation	Skewness
Achievement/m	61.15	71.90	67.20	2.70	4.02	-0.38
Mass/ kg	100	139.00	118.65	10.30	8.68	0.03
Height/ m	1.84	2.09	1.96	0.06	3.06	-0.02
Releases height/ m	1.50	1.87	1.67	0.11	6.59	0.35
The ratio of the releases height to the thrower height / %	75	96	85.32	5.89	6.90	0.25

The coefficient of variation differs from the homoscedasticity of the study sample members in the variables shown. The preferred values for the difference coefficient are usually less than 50A review of the anthropometric values of the study sample showed that the highest coefficient of variation was 8.68% for mass. Since this value is very low, it can be concluded that the sample is homoscedastic for these variables. Table 1 also showed the values of the skewness coefficients of the study variables. It is known that skewness is a measure of the level of data distribution and its relation to the natural data distribution curve (default), and the values of the skewness coefficient are usually accepted between the values (1.96±) (Orcan, 2020). In addition, the skewness is the third torque around the arithmetic mean, where it showed that the maximum value has been (0.38) this value falls within the normal range values of the skewness coefficients. It should also be noted that ensuring the normal distribution of data is an important condition that must be verified before using regression analysis.

2.3. Statistical Analysis

To process the study data, the researchers used the arithmetic mean, standard deviation, skewness coefficient, coefficient of variation, simple linear regression analysis to obtain an equation for predicting the optimal release height in the discus event, and percentages, all computed using SPSS statistical software (Version 23; SPSS, Chicago, IL, USA), with a significance level of 0.05.

3. RESULTS

Table 2 shows the quantitative data of the study sample, including height, horizontal displacement, release height, and the ratio of release height to the thrower's height.

Table 2. Quantitative date of the study sample

Achievement Horizontal displacement/m	Height/m	Release height/m	The ratio of the height of the release to the thrower height/ %
71.9	1.97	1.64	83.25
71.3	1.98	1.6	81
70.86	1.84	1.54	84
70.18	1.94	1.6	82.4
69.8	2.01	1.56	77.7
69.62	1.87	1.81	96
69.43	2.01	1.62	80.6
69.4	1.94	1.5	77.3
69.15	1.92	1.81	94
69.02	1.93	1.68	87
68.52	1.98	1.87	95
68.2	1.97	1.58	80.2
67.94	2.06	1.79	87
67.34	2.02	1.65	82
66.88	1.96	1.63	83
66.6	1.96	1.8	92
66.12	2.01	1.66	83
66.06	1.98	1.85	93
65.8	1.92	1.6	83.3
65.66	1.9	1.79	94
65.3	1.97	1.51	77
65.26	1.98	1.58	80
65.17	2.09	1.56	75
65.02	1.97	1.75	89
64.62	1.97	1.67	85
64.44	1.85	1.6	86.5
62.2	1.84	1.54	84
62.02	1.85	1.77	95
61.26	1.92	1.7	88.5
61.15	1.93	1.78	92
66.87	1.95	1.67	85.6
2.94	0.062	0.108	6.05

The table shows that the throwers' release height averages around 83% of their body height, with mean height 1.95 m, mean release height 1.64 m, and mean horizontal displacement 66.87 m, indicating a relatively consistent proportional relationship between thrower height and release height.

Below, Table 3 shows the results of a simple linear regression analysis to investigate the effect of the thrower height variable on the ratio of the release height to the thrower height.

Table 3. Results of simple linear regression analysis

Independent variable	R	R^2	Adjusted R^2	F	p value
Thrower height	0.433	0.19	0.158	6.24	.019

a. Predictors (ratio of the height of the release to the thrower height)

Table 3 indicates a statistically significant relationship between thrower height and the ratio of release height to thrower height ($p = 0.019$). The model explains about 19% of the variance ($R^2 = 0.19$), with a moderate positive correlation ($R = 0.433$). Table 4 shows demonstrate the standard and non-standard effect values of the simple linear regression analysis model.

Table 4. Rustle of coefficients

Independent variable	B	T	p value	Fixed limit
Thrower height	-46.121	-2.49	.019	175.66

The results of the table above show that thrower height had a significant negative effect on the ratio of release height to thrower height ($p = 0.019$, $t = -2.49$). The unstandardized coefficient ($B = -46.121$) indicates that as thrower height increases, the ratio of release height to thrower height decreases slightly, meaning taller throwers tend to have proportionally lower release point. In the following. Table 5 shows the results of estimated equation accuracy through the thrower height ratio to the percentage of the release height of the discus throw event.

Table 5. The results of the accuracy indicators of the forecast equation reached

Kinematic variables	Minimum	Maximum	Mean	SD
Forecast error rate to real values	0.06	5.10	5.10	3.30

The forecast equation predicting the release height percentage from thrower height had a mean error rate of 5.10%, with a standard deviation of 3.30%. The small error range (minimum 0.06%, maximum 5.10%) indicates that the regression model provided a reasonably accurate prediction of the release height ratio in the discus throw event.

4. DISCUSSION

The discrete point in this research was to identify the optimum height release in the discus throw event in proportion to the thrower height. In addition, finding an estimated equation that helps to determine the optimal height release in a discus throw event. This help coaches to choose this variable by objective method away from random, and minimizing the use of trial and error. Consequently, the results of this study showed that the percentage of the high release of the discus throw event ranged between 75-96% of the thrower height and an average of 85.6%, which is within previous results reported by Abdel-Monsef Aly et al. (2012) (86%); Abdel Fattah et al. (2014) (82%). Leigh et al. (2008) stated that the optimal height of the height release is when the discus reaches the level of the thrower's shoulder, which allows the thrower to create the largest velocity of the discus, thus contributing to the largest horizontal displacement of the discus. Notably, there is a statistically significant correlation between the thrower's height and the distance of achievement in the discus throw event (Hamoury & Alhayek, 2006). Also, they are related to the anthropometric measurements of the thrower (Cho et al., 2008). Therefore we need to investigate the effect of the thrower height Variable on the ratio of the releases, based on the results of the simple linear regression analysis indicate the value of the relationship between the height thrower variable and the release height ratio (0.433), which is statistically significant, because the calculated f value (6.24) was statistically significant (0.019). This result indicates the significance of the relationship between the two variables. The values of the parameters of the coefficient of determination or interpretation (R2) indicate the significance of the kinematic variable in the interpretation of the variance for the dependent variable (the ratio of throwing height to total body length), which reached 18.8%.

This ratio is acceptable as it expresses only one independent variable. Based on the height of the discus release is closely associated with technique characteristics and the height of athletes, In addition, the release high of the discus depends on the thrower's height and in which position the discus is thrown. The description of the technique used by elite throwers gives an insight into the individual models of these throwers to regulate their use for high performance. These models eventually become references that help coaches and athletes to achieve maximum mechanical efficiency through interrelationships between kinematic variables that affecting on achievement. Notably, the height at which a projectile is released also has implications for the optimum angle of release. Considering that we are trying to determine the optimum release height for discus without affecting the velocity and angle releases. Notably that performing throw discus with fast velocity and optimal angle without paying attention to the release height will adversely affect the optimal achievement. For the benefit of the coaches, the researchers were able to provide an estimated equation for predicting the optimal release height of the discus to the thrower height, which came as follows:

Release height (m) = - 46.121 x thrower height (m) + 175.66

The value of the independent variable (height thrower) which has been accepted in the dependent variable (the ratio of the release height of the discus to the thrower height) in the linear regression model reached (B= - 46.121). Since the value of the significance level reached (0.019) was less than 0.05, therefore the value of the effect of the independent variable on the dependent variable reached in the regression model is considered important in this model. The minimum error rate calculated for the dependent variable was (0.06), and the maximum error rate was calculated due to an error of prediction attributed to the dependent variable (11.49), note that the maximum value is considered to be low, considering that the average accuracy of the prediction (expressed as forecast error rate to the dependent variable) has reached (5.10), furthermore it's a low error value and indicates of the quality estimated equation reached.

5. CONCLUSIONS

Although release velocity, height, and angle are commonly identified as the most important biomechanical parameters in studies conducted during major track and field competitions, the release velocity has a greater influence on the achieved distance than either the release angle or the relative release height. The researchers concluded that there was a statistically significant relationship between the thrower's height and the release height ratio, and they provided an estimated equation for predicting the optimal release height of the discus based on the thrower's height. These findings suggest that thrower height plays a meaningful role in determining the optimal release height, providing practical guidance for coaches and athletes to improve discus throw performance.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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