INTRODUCTION

Hammer throwing dates back as far as 1800 B.C. in Ireland. Today, men throw a 7.26 kg implement while women throw 4.00 kg. The event was included in the 1900 Olympic Games for men and began in 2000 for women. The hammer throw is one of the more technical events in track and field that requires a unique combination of power, stability, and coordination. The required technique for positioning the body and applying the torques to increase angular momentum of the hammer-thrower system must be nearly perfect for a successful hammer throw due to the large centripetal forces.

As with most throwing events in track and field, maximizing the magnitude of release velocity is the primary focus [1]. With the complexity of the movement, determining which characteristics of technique apply best to increasing release velocity can be difficult. In angular motion, a change in one variable often has a meaningful effect on another variable. However, it is clear that the larger the torque the athlete can generate will lead to greater changes in angular momentum of the hammer-thrower system [2].

During the double support phase of each turn (when both feet are on the ground) large torques can be generated. The rotation of the trunk along with the action of the lower body may relate to the amount of torque exerted. This study investigated whether the angular range during double support between the shoulder and hip lines from a longitudinal axis related to the distance thrown. Since the time the torque is applied also determines the changes in angular momentum, an analysis of the timing of foot placements was also completed.

METHODS

Two digital camcorders (Canon Elura 60, Lake Success, NY) were placed perpendicular to each other and zoomed in to view the entire movement of the thrower and hammer. Peak Motus 8.5 was used to digitize and calculate three-dimensional coordinates of the hammer head, shoulders, and hips for every throw at the 2008 Mt SAC Relays, 2008 BYU High Performance Meet, and the 2008 US Olympic Trials. Altogether, 80 throws were digitized from the men’s and women’s events at these meets.

Throwing distance, timing of double and single support phases, and positioning of the hips relative to the hammer head at the beginning of double and single support were measured and recorded.

Linear regressions were performed to determine any factors that were related to throwing distance.

RESULTS AND DISCUSSION

The angular range of the shoulder to hip angle during double support was significantly related to throwing distance during the second turn, but not
any other turns \((R^2=0.33, \ p<0.01\) and \(R^2=0.15, \ p<0.04\) for women and men respectively, Figure 1). However, there was a large variability in the angular range showing that there are other factors of great importance to consider \((\text{mean} \pm \text{SD} = 27 \pm 15\ \text{deg} \ for \ women \ and \ 41 \pm 15 \ \text{deg} \ for \ men)\).

![Figure 1: The relationship between angular range of the shoulder to hip angle versus distance for men and women during the second turn.](image)

Another factor we measured was timing of single and double support phases. A surprising finding occurred. Significance only showed up in the second turn, similar to the angular range data. The ratio of double to single support for women was a predictor of distance \((R^2=0.29, \ p=0.04)\) with less time in double support relating to greater throwing distance. For men, less time spent in double support led to greater throwing distances \((R^2=0.33, \ p=0.03)\). The greater range of motion in a shorter amount of time demonstrates large increases in angular momentum being generated during double support of the second turn.

All significant findings occurred during turn two. Major increases in linear velocity of the hammer occur during double support [2]. While the movement patterns and torques generated in other turns must be of importance, it seems that the second turn is critical in effective hammer throwing.

However, the observed trends were difficult to detect since much variability shows up comparing person to person. Since clear trends with these variables failed to show strong correlations, there must be other major factors that predict throwing distance better. The torques that a hammer thrower generates to build up angular momentum were not measured in this study. This is likely the main factor to consider in the future. The larger the torque regardless of the positions used, the greater the change in angular momentum. One other factor to consider is due to the nature of manual digitizing, some variability is to be expected.

**SUMMARY/CONCLUSIONS**

This study showed that during turn two, the best throws occur when a large range of motion occurs in trunk rotation during double support during a relatively short amount of time. Coaches and athletes should focus on improving the range of motion through the trunk and other methods for producing large torques that shorten the time spent in double support. This is especially important during turn two, but the other turns should not be ignored since there are clearly other factors of importance in hammer throwing that this study did not detect.

**REFERENCES**


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