Elite Level Development Rates and Age-Based Performance Patterns for the Men's Throwing Events

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ABSTRACT

In addition to differences in rates of progression among individual athletes, it is known that each event has its own average development profile. The purpose of this study was to provide guidelines to athletes and coaches in each of the men's throwing events by examining the performances of the athletes who have dominated at recent Olympic Games and IAAF World Championships in Athletics. The authors, both experienced coaches, analysed the age and yearly best performances of sample groups of 23 or 24 performers active in each of the four events since 2005. They found, for example, that on average world-class men's javelin throwers maximise their performance at a younger age than athletes the other men's throwing events and that while elite men's discus and hammer throwers display slower development, they have smaller drop-offs in performance after their peaks are reached. The authors' data is presented in tables that provide benchmark percentages of eventual personal bests at each age in each of the four events for throwers aspiring to world-class.

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Introduction

This study was influenced by the work of Tilinger, Kovar, & Hlavata on the dynamic progress of performances of world-class athletes in selected track and field events from 2005. While their study examined data from a variety of running and field events, the scope of this project is exclusively the men's throwing events with the subject groups consisting of 23 or 24 all-time best performers in each of the four throwing disciplines (shot put, discus, javelin, and hammer). The members of these elite subject groups have shown to be the predominant medal winners at the sport's highest levels (Olympic Games and IAAF World Championships in Athletics).

The aim of the study was to examine the performance data in such a way as to give an

idea of what to expect when striving for elite performance by:

1. Calculating the average age of top performance for each of the four throwing disciplines.

2. Generating an age-based table of performance norms for the all-time best throwers in each throwing event.

3. Comparing and contrasting the development rates of the four throwing disciplines as they pertain to reaching top performance.

Overview of the Group Data

Preliminary calculations were made to find the average age for achievement of personal best and average birth year for each throwing group. The overall results showed that the top throwers realised their best marks in their mid- to late-twenties. A more detailed examination of Table 1 reveals that the discus and hammer groups were roughly 10% older than the shot put and hammer groups when it came to the average age that the athletes produced their personal bests.

A potential explanation for the age difference in reaching top performance in the discus and hammer versus the shot put and javelin may be that the discus and javelin are more rhythmic events that require many more throws and practice time to perfect the optimal technique for an individual. It should also be noted that the overall delivery paths for the discus and hammer throws are significantly longer than for the shot put and javelin throw. In addition, the contribution of the final delivery phase of both the discus (~55%) and hammer (~15%) to the final release speed is smaller than for the shot put (~82%) and javelin (~75%). These factors suggest that the throwing movements, overall, are more intricate for the discus and hammer throw, thus necessitating more time and repetition to achieve top results in comparison to the shot put and javelin.

A further stratification of data was also made for the shot put as there are two distinct techniques used in the event. Table 2 highlights these calculations. As one can see, the figures are fairly equal except for the average birth year of the top throwers. The javelin, as expected, had the youngest group of top performers due to the fact that the new rule javelin changes were implemented in 1986. It is interesting to note there is a nine-year difference between the top practitioners of the rotational shot put technique (1971.7) versus the glide technique (1962.7). When the glide group's average birth year was adjusted so that it was equivalent to the top rotational throwers, the performance levels adjusted down significantly (see Figure 1). This suggests that the very elite gliders were much more prevalent in the past

Table 1: Details of elite athlete performance development in the men's throwing events

	Shot Put	Javelin	Discus	Hammer
Average Birth Year	1969.7	1973.4	1964.7	1968.1
Average Age for PB	27.3	25.0	29.1	29.2
Avg. Personal Best	22.33m	90.50m	71.39m	83.74m
High PB in Sample	23.12m	98.48m	74.08m	86.74m
Low PB in Sample	21.92m	88.22m	69.91m	82.40m
Number in Sample	24	23	24	24

Table 2: Details of elite athlete performance development in the men's shot put

	Rotational Shot Put	Glide Shot Put
Average Birth Year	1971.7	1962.7
Average Age for PB	28.0	26.9
Average Personal Best	22.00m	22.06m
Highest PB in Sample	23.12m	23.06m
Lowest PB in Sample	21.47m	21.68m
Number in Sample	24	23

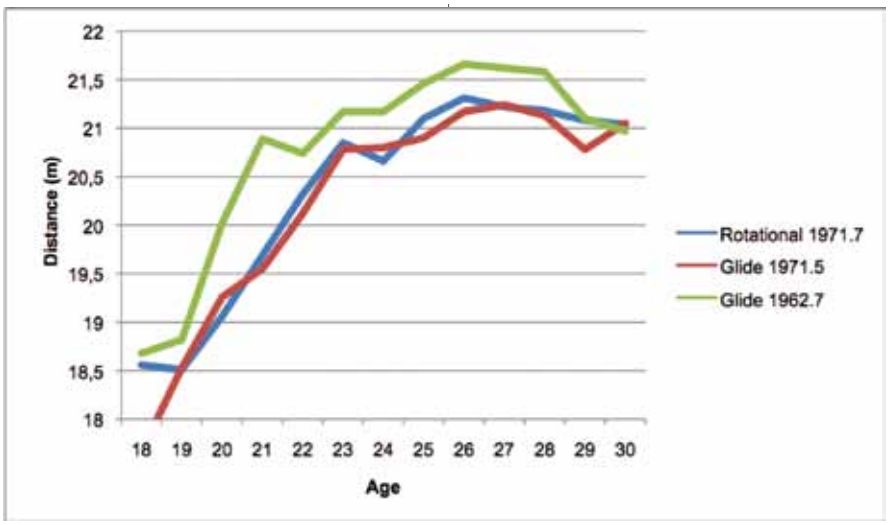


Figure 1: Progress by age for elite men's shot putters

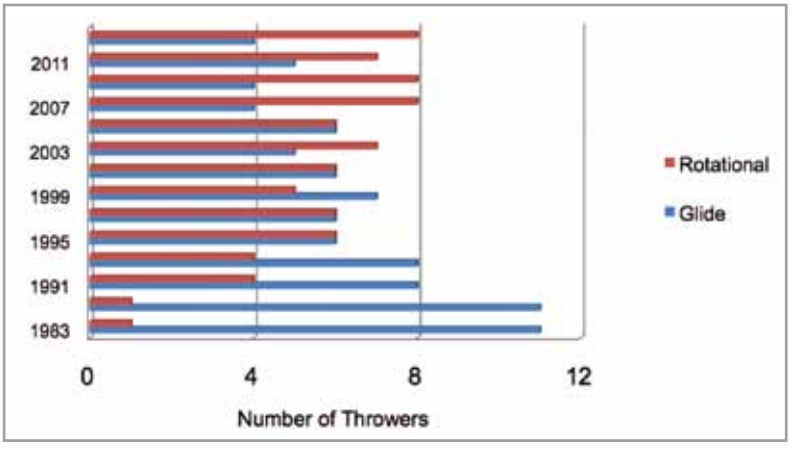


Figure 2: Technique used by Men's Shot Put finalists at selected IAAF World Championships in Athletics

and are not as common in recent years. This idea can be supported by the fact that the finalists in the Olympic Games/World Championships have transformed from an 11/1 glide to rotational ratio in 1983, to between a 2/10 and 4/8 glide to rotational thrower ratio in the more recent major championships (see Figure 2).

Performance by Age

Table 3 shows the average best for each elite group of the four throwing disciplines at a given age. This simple calculation was done averaging the best performances by the members of each group for every age between 18 to 30 years of age. From these numbers, one can have a general idea of what developmental markers a potential medallist would need to reach in a particular event at a given age.

The rate of development as it pertains to biological age was calculated for each discipline by creating a chart plotting the percentage of a given group's maximum performance for that year. Table 4 illustrates an example of how this data was formatted for the javelin throw. Figure 3 shows that the shot put group was found to be the one that reached the highest maximum performance level at the youngest age (26 years). The javelin group followed at 27 years and the hammer and discus groups at an average age of 28.

The discus displayed the slowest rate of development, but showed the lowest drop off in terms of age related performance after maximum performance was achieved. The hammer throw displayed a similar pattern, supporting the notion that these two events take longer

Table 3: Average performances of elite men throwers at different ages

Age	Shot Put	Discus	Hammer	Javelin
18	18.30m	55.66m	69.39m	73.94m
19	19.03m	58.92m	71.55m	76.70m
20	19.49m	61.17m	75.27m	80.67m
21	19.95m	61.15m	76.98m	82.44m
22	20.87m	62.91m	77.85m	84.88m
23	21.27m	65.23m	79.51m	86.13m
24	21.09m	66.70m	80.45m	85.81m
25	21.50m	67.61m	79.83m	86.68m
26	21.66m	68.56m	80.68m	86.52m
27	21.61m	68.56m	80.68m	87.71m
28	21.52m	68.63m	81.93m	86.90m
29	21.25m	68.58m	81.34m	85.25m
30	21.20m	68.37m	81.20m	83.58m

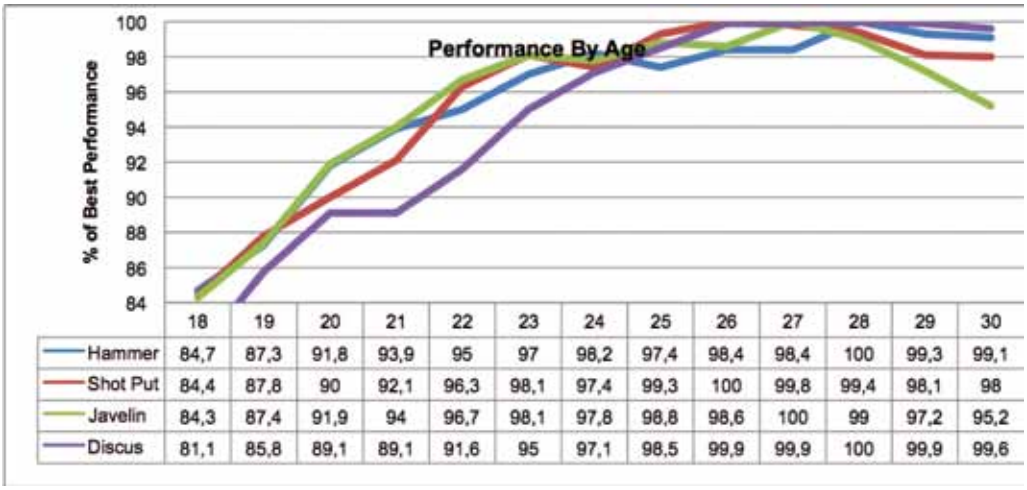
Table 4: Average percentage of personal best performance at different ages for elite men's javelin throwers

	Javelin	
Age	**Performance**	**% of Max. Performance**
18	73.94m	84.3%
19	76.70m	87.4%
20	80.67m	91.9%
21	82.44m	94.0%
22	84.88m	96.7%
23	86.13m	98.1%
24	85.81m	97.8%
25	86.68m	98.8%
26	86.52m	98.6%
27	87.71m	100%
28	86.90m	99.0%
29	85.25m	97.2%
30	83.58m	95.2%

to achieve peak performance with the prime performance years going well past 30 years of age. Conversely, the javelin throw, appears to have the fastest rate of development, as well as the quickest rate of decline in performance. Further research into the performance levels of these groups between ages 31 to 35 could perhaps shed further light on the long-term rates of decline.

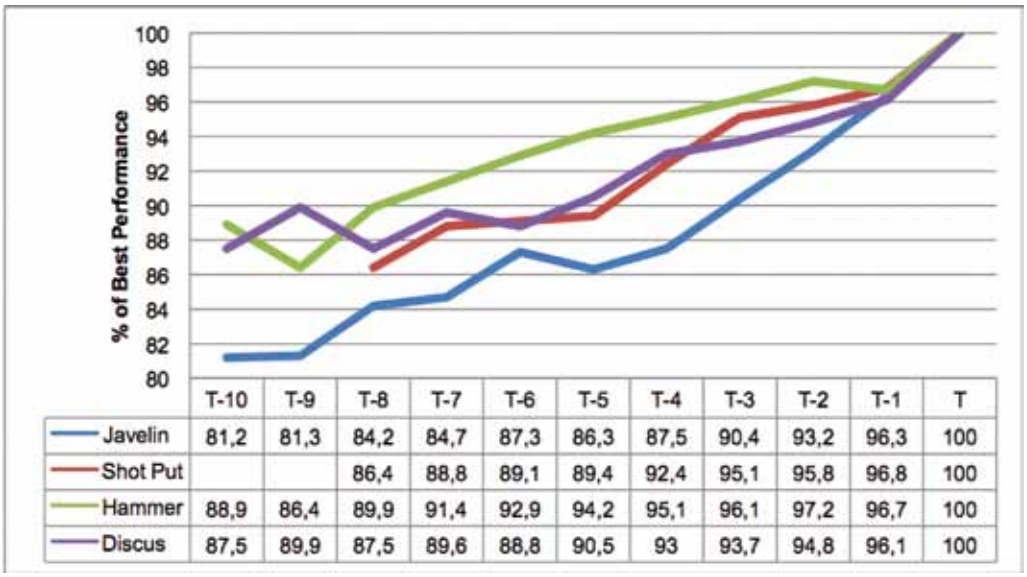
Years to Best Mark

A second analysis of performance development was conducted by charting each throwing group's rate of development toward their best performance, with T indicating the year of best performance (see Figure 4). This was done for either an eight or 10-year period leading up to maximum performance. Unlike the TILINGER ET AL study, which charted performance going back to the initiation of full time training, this study was limited to a period of no more than 10 years prior to the achievement of best performance. For most of the athletes in this study the analysis began around their third or fourth year of full time training. Investigating a longer period of development was also complicated by the fact that many of the throwers born after 1985 used different weighed implements at the junior level so it is problematic



	18	19	20	21	22	23	24	25	26	27	28	29	30
Hammer	84,7	87,3	91,8	93,9	95	97	98,2	97,4	98,4	98,4	100	99,3	99,1
Shot Put	84,4	87,8	90	92,1	96,3	98,1	97,4	99,3	100	99,8	99,4	98,1	98
Javelin	84,3	87,4	91,9	94	96,7	98,1	97,8	98,8	98,6	100	99	97,2	95,2
Discus	81,1	85,8	89,1	89,1	91,6	95	97,1	98,5	99,9	99,9	100	99,9	99,6

Figure 3: Average percentage of personal best performance by age in the men's throwing events



	T-10	T-9	T-8	T-7	T-6	T-5	T-4	T-3	T-2	T-1	T
Javelin	81,2	81,3	84,2	84,7	87,3	86,3	87,5	90,4	93,2	96,3	100
Shot Put			86,4	88,8	89,1	89,4	92,4	95,1	95,8	96,8	100
Hammer	88,9	86,4	89,9	91,4	92,9	94,2	95,1	96,1	97,2	96,7	100
Discus	87,5	89,9	87,5	89,6	88,8	90,5	93	93,7	94,8	96,1	100

Figure 4: Average percentage of personal best performance in the years before the mark was achieved (T) for elite men throwers

to convert their junior performances (with the javelin, hammer and discus) to those with the senior implements.

The analysis demonstrated the rate of improvement from year to year toward the top results that the athletes produced. As confirmed by the age group analysis, the javelin showed the steepest rate of improvement toward peak performance. The hammer throw showed the slowest, or most gradual rate of development over the 10 years leading up to best performance.

Conclusion

There are a variety of observations that can be drawn from this data analysis. These are subjective in nature, and can be used as a rough outline for coaches and athletes to follow when planning and comparing their long-term training with those of the elite in the throwing events. A more detailed study and analysis will be necessary to generate results of statistical significance.

As a group, the men's throwers appeared to reach their peak years of performance in the late 20's. The discus and hammer throws, which are the most rotational and rhythmically dependent events, had the latest average age of best performance at 29 years of age. These two events also displayed the slowest drop-off in performance after the best performance was reached. Further investigation into erosion of performance rates going into the early- to mid-30's would provide for an interesting future study.

It was also evident that a more dynamic event, like the javelin in which elite performance requires a release velocity of up to 30 m/sec, had a more rapid rate of development than the other throwing events. Conversely, because of the explosive nature of the event, an elite athlete's performance window does not appear to last as long as the other throwing events.

One final trend that was observed is that the rotational shot seems to be solidifying itself as the primary technical model for elite shot put-

ters. This is not to say that the glide variation is not a highly successful technique, but that the vast majority of top male throwers in the past 20 years using the rotational technique have a virtual monopoly on performances over 22m. Perhaps the most likely reason for this development is the ability of the rotational technique to suit a wider range of body types/nervous systems than the glide technique.

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