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A Trend Analysis of Major Championships Results in Male Hammer Throw (2008–2017)

Donald G. Babbitt
Track & Field Department, University of Georgia Athletic Association, Georgia, USA

Corresponding Author: Donald G. Babbitt
Address: 100 Smith Street, Athens, GA 30605, USA
E-mail: dbabbitt@sports.uga.edu
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Abstract

The study obtained performance results for a total of 93 men's hammer throwers who participated in major championships (Olympic Games or International Association of Athletics Federations [IAAF] World Championships) between the years 2008–2017. Data was analyzed to find performance trends in the finals of these championships relative to age, number of previous major championship appearances, seasonal best, and the average of the three best competition results for a given season. Downward trends were found for all of these metrics in the time period studied. Correlations coefficients were generated for six different variables (age, number of major championships appearances, seasonal best, best three-meet average, result in qualifying, and performance quotient of qualification round [$PQ_{qualification}$]) in relation distance thrown in the final and PQ_{final}. The strongest correlations to finals performance were found be with actual distance thrown in the qualifying round (r = .6493, p < .00001), the average of the three best competition results of the year leading in to championships (r = .5682, p < .00001), and the seasonal best performance (r = .5244, p < .00001). There was also a strong correlation found between the $PQ_{qualification}$ and the PQ_{final} (r = .5317, p < .00001). Results from this study may be useful in guiding coaches, athletes, and federations in their preparation for future major championships in men's hammer throw.

Keywords: hammer, prediction, Olympics, championship, men

Introduction

The hammer throw is one of four throwing events (hammer, shot put, discus, and javelin) that is regularly contested in the event program for the sport of track and field. The Olympic Games and International Association of Athletics Federations (IAAF) World Championships are considered the two most important competitions for the hammer throw at the sports highest level (Mack, 2016). In both of these events, the world's top 32 competitors are invited to compete for the gold medal, which is considered the sports highest honor. There have been a number of studies that have examined various aspects of throwing performance in all four of these throwing events with many of these investigations having directed their effort on determine what performance metrics are correlated with throwing performance. The majority of these studies have been focused on the relationship between biomechanical factors, such as release speed, release angle, and height of release, to describe the elements of throwing performance (Badura, 2010; Gutierrez, Soto, & Rojas 2002; Isele & Nixdorf, 2010; Morriss, Bartlett, & Fowler, 1997; Murakami, Tanabe, Ishikawa, & Ito, 2017). Additionally, a number of researchers have also examined the correlation between throwing performance and weight lifting exercises (Judge & Bellar, 2012; Judge, Bellar, McAtee, & Judge, 2010; Judge et al., 2011), or specific strength exercises (Bondarchuk, 2007; Bondarchuk, Ivanova, & Vinnitchuk, 1977; Karampatsos, Korfiatis, Zara, Georgiadis, & Terzis, 2017). However, there is a paucity of research relative factors that may predict performance specifically in the Olympic Games or World Championships.

With regard to elite competitions (World Championships and Olympic Games) there is only a small amount of research that has attempted to quantify variables associated with success, or identify predictors of performance outcomes. In one of the initial pieces of research on quantifying variables for success, Ward, Morrow, Omizo, and Michael (1979) reported that self-report personality measures showed little benefit as predictors of success for Olympic level athletes in the four throwing disciplines. In another study focusing on performance prediction, Pilianidis, Mantzouranis, Kyriakoulakis, Proios, and Kotzamanidis (2012) used regression analysis to chronicle high prediction of performance accuracy in the men's throwing events at the Mediterranean Games. The intent of this research was to provide coaches with information to help design training programs for success at the subsequent Mediterranean Games in 2013. The researchers reported that the men's hammer throw specifically had the highest prediction validity of all the throwing events. With a similar focus on performance prediction, Zhang, Qin, Xu, and Zeng (2011) used document and mathematical statistics to predict the gold medal winning performance for the women's shot put in the 2012 Olympic Games, based on gold medal performances from the previous five Olympic Games between 1992–2008. As with the case of Pilianidis et al., the motivation for this study was to provide information to guide a planning model for Chinese shot putters in preparation for the 2012 London Olympics. In retrospect, this study underestimated the winning throw by nearly 70 cm, but with a subsequent doping disqualification for the winner, it was adjusted to 33 cm.

In a different line of investigation, Pavlovic and Idrizovic (2014) undertook a study to determine the difference in results between

male and female javelin finalists at the London Olympic Games in 2012. The researchers also sought to see if the performances in the qualifying rounds were significantly related to results in the final rounds for both genders. No statistical differences were found for each gender's performance from the qualifying to final rounds, however, it was observed that, surprisingly, only 33% of the competitors threw better in the final than in qualifying. This led the researchers to suggest that further investigation into the cause for this drop in performance was warranted.

There are some unique factors to the men's hammer throw's development that make the nature of the future performance prediction distinctly different from the other men's throwing events. Over the past five decades, hammer throw technique has evolved significantly as an event with the advent of "modern" hammer technique pioneered by the throwers of the Soviet Union in the 1970's and 1980's (Babbitt, 2003). Men's hammer performance levels reached a crescendo in the late 1980's and early 1990's with throwers such as Iouri Sedykh and Sergey Litvinov throwing in excess of 86 meters. Top standards remained well above the 80-meter level through the 1990's and into the early 2000's. However, unlike the majority of the men's throwing events, hammer performance levels have begun to decline over the past decade, and it is now a rare exception to have a thrower performing over the 80-meter level.

The purpose of this study was to identify the current performance trends for the men's hammer throw at the major championships over the past 10 years, in order to contrast and compare with the body of research in this area, and to shed a brighter light on the impact of various performance metrics for the event. In addition, calculations were made to identify significant correlations between selected variables going into competition to assess any significant influence they had on performance. Given the apparent regression of men's hammer performance over the past 10 years, it was hoped that key indicators, such as age, championship experience, and previous performance, could be tested so that coaches and athletes, alike, will be better able to predict, select, and prepare training for greater success in men's hammer at the major championships. It is hypothesized that factors such as age, championship experience, and previous performance will be statistically significant predictors of major championship performance.

Methods

The study obtained performance results for a total of 93 men's hammer throwers who participated in major championships (Olympic Games or IAAF World Championships) between the years 2008–2017. Performances by athlete's who had failed doping tests at any of these competitions were not considered for the study. The performance data was derived from competition results from both the official IAAF (n.d.) and Tilastopaja (n.d.) websites. Data for each athlete who competed in the final of each championship were recorded for age, number of major championship appearances, qualification performance, final performance, season best, and the average for the three best competition results for that given year. Additionally, a performance quotient (*PQ*) was calculated for both the qualification and final rounds for each major championship in order to quantify how well they performed to their potential based on their seasonal results going into the championship. *PQ* was calculated

by dividing the distance thrown in either the qualification round (Q) or final round (F) of the championship by the average of the three best competition results for that season (X) using the following formulas.

$$PQ_{qualification} = \frac{Q}{X}; \quad (1)$$

$$PQ_{final} = \frac{F}{X}. \quad (2)$$

Units for the PQ would are expressed as a percentage. A score of 100% (expressed as 100.0) would be earned if the qualifying or final performance would be equal to the average of the three best competition results for the given season. The best three-meet average (X) was calculated by dividing the sum of the three best competition results (x_1, x_2, x_3) for a given season by the number of competitions (three) as shown in the following equation:

$$X = \frac{1}{3}(x_1 + x_2 + x_3). \quad (3)$$

Averages were then tallied for age, number of major championship appearances, qualification result, final result, season best (SB), best three-meet average (X), qualification PQ, and final PQ for the competitor groups for each major championship for the years that were studied. Calculations of Pearson's correlation coefficient for six different variables (age, number of major championships appearances, seasonal best, best three-meet average, result in qualifying, and $PQ_{qualification}$) in relation distance thrown in the final and PQ_{final}. A current statistical software package (IBM SPSS Statistics Version 25.0) was used to perform the analysis and statistical significance was set at $p < .05$.

Results

Data collected (final result, qualifying result, age, major championship appearances, seasonal best, and the average of the three best competition results) from the results for the finalists in all the major outdoor track and field championships from 2008 to 2017 were averaged and presented in Tables 1 and 2. The performance quotients for both the qualification and final rounds were also calculated and averaged. These appeared to remain steady through this time period (see Tables 1 and 2). As could be expected, the performance quotients were slightly higher for the final round compared with the qualifying round due to the three extra attempts awarded in the final round for the top eight throwers, and the desire to achieve a maximum result by all finalists as opposed to a fixed qualifying result. Results for the average qualifying mark, final mark, and seasonal best were plotted on a chart and trend lines were calculated and presented in Figure 1 to show the downward trend in hammer performance over the past 10 years. The linear trend lines in Figure 1 clearly highlight a steady decline of nearly two meters for each performance category over the past 10 years for the average result of these three variables. Negative trend lines were also observed for age (Figure 2), major championship appearances (Figure 3), and $PQ_{qualification}$ and PQ_{final} (Figure 4).

Tests were performed for Pearson's correlation coefficient (r) for six different variables (age, number of major championships appearances, seasonal best, best three-meet average, result in qualifying, and $PQ_{qualification}$) in

Table 1

The Averages Are Listed for Results in Final, Results in Qualification, Age, and Number of Major Championship Appearances for Each Major Championship

Major championship	Final (m)	Qualification (m)	Age (yr)	MCA
2008 Olympic Games	79.18 ± 2.14	77.79 ± 1.43	29.0 ± 2.67	6.0 ± 2.08
2009 World Championships	76.25 ± 2.62	77.07 ± 0.92	28.7 ± 3.44	5.4 ± 3.04
2011 World Championships	78.26 ± 1.81	76.97 ± 0.83	31.1 ± 4.38	6.7 ± 3.96
2012 Olympic Games	76.54 ± 2.48	76.63 ± 1.55	31.5 ± 3.98	6.3 ± 3.86
2013 World Championships	77.92 ± 2.08	76.97 ± 1.19	31.3 ± 4.85	7.4 ± 3.88
2015 World Championships	76.23 ± 2.48	76.06 ± 1.08	28.1 ± 4.07	3.8 ± 2.64
2016 Olympic Games	75.52 ± 1.76	75.07 ± 1.61	29.9 ± 5.91	4.6 ± 3.67
2017 World Championships	76.78 ± 1.58	75.60 ± 0.72	27.1 ± 5.35	3.5 ± 2.62

Note. MCA = major championship appearances.

Table 2

The Averages Are Listed for Seasonal Bests, Average of the Best Competition Results for that Year, Performance Quotient in Final, and Performance Quotient in Qualifying for Each Major Championship

Major championship	*SB* (m)	*X* (m)	PQ_{final}	$PQ_{qualification}$
2008 Olympic Games	80.48 ± 1.79	79.70 ± 1.96	99.2 ± 2.13	97.6 ± 1.84
2009 World Championships	79.06 ± 1.25	78.56 ± 1.31	96.8 ± 3.35	98.2 ± 1.57
2011 World Championships	78.85 ± 1.26	78.20 ± 1.24	99.8 ± 2.33	98.2 ± 1.54
2012 Olympic Games	77.50 ± 2.39	76.86 ± 2.26	99.6 ± 3.76	99.7 ± 3.39
2013 World Championships	79.13 ± 1.57	78.54 ± 1.49	99.0 ± 2.38	97.9 ± 1.22
2015 World Championships	78.34 ± 2.32	77.63 ± 2.25	98.0 ± 1.98	97.8 ± 2.23
2016 Olympic Games	77.95 ± .966	76.82 ± 1.24	98.3 ± 1.79	97.8 ± 1.50
2017 World Championships	78.42 ± 1.87	77.77 ± 1.88	98.7 ± 0.72	97.2 ± 1.62

Note. *SB* = seasonal best; *X* = three best meet average.

relation distance thrown in the final and PQ_{final}. The results of the correlations were reported in Table 3 in descending order from highest to lowest correlation between variables. The strongest correlations to finals performance were found be with actual distance thrown in the qualifying round (r = .6493, p < .00001), the average of the three best competition results of the year leading in to championships (r = .5682, p < .00001), and the seasonal best performance (r = .5244, p < .00001). There was also a strong correlation found between the $PQ_{qualification}$ and the PQ_{final} (r = .5317, p < .00001). Positive correlations of statistical significance were also found between the number of major championship appearances and the performance in the final (r = .3094, p < .01) and the PQ_{final} (r = .3196, p < .01). Conversely, statistically significant negative correlations were found between both the seasonal best (r = -.2773, p <

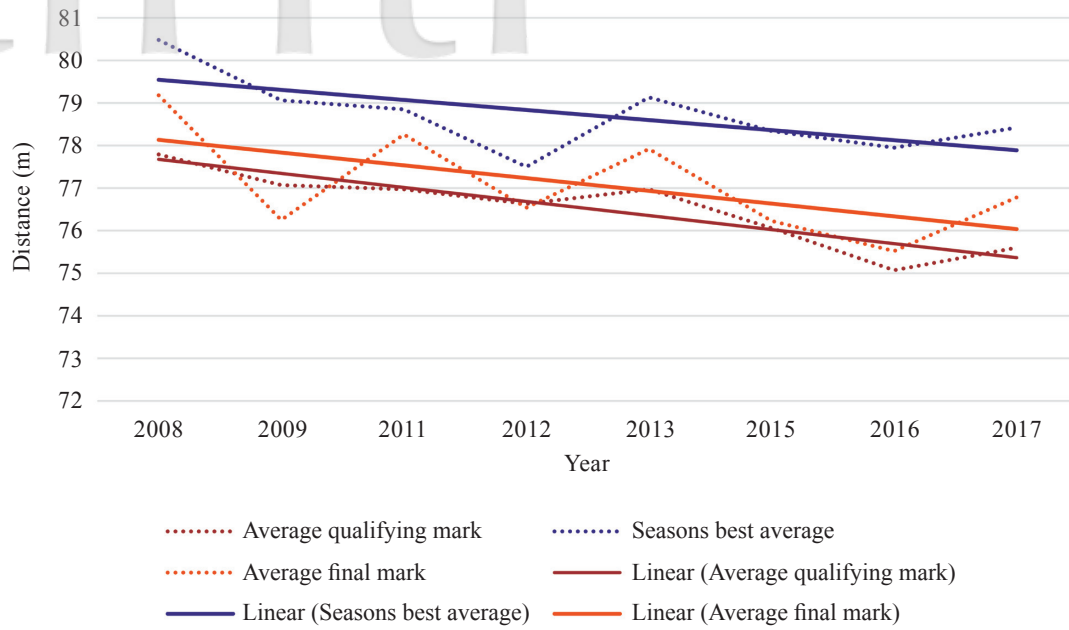

Figure 1. Trends in men's hammer performance at major championships between 2008 and 2017.

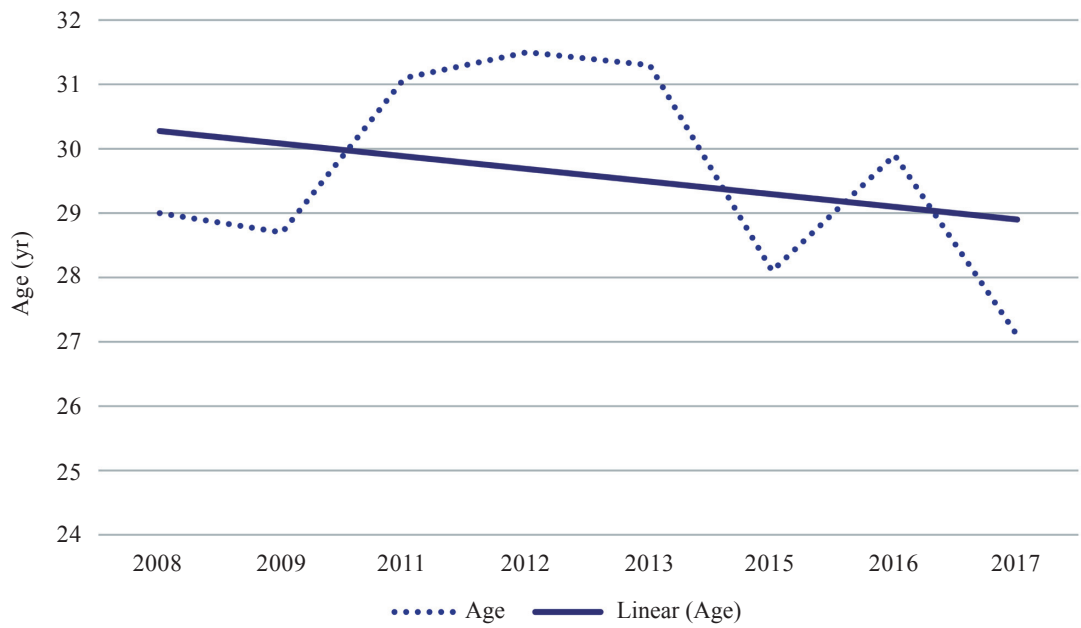

Figure 2. The trend-line for average age of the major championship finalists in men's hammer from 2008 to 2017.

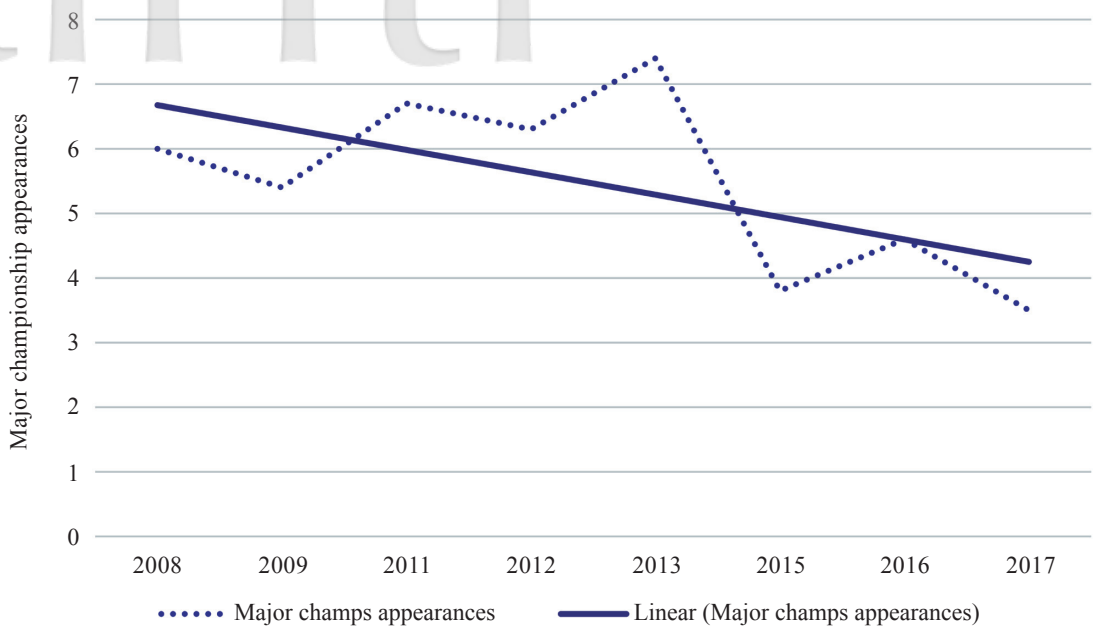

Figure 3. The trend-line for the average number of previous major championship appearances of the major championship finalists in men's hammer from 2008 to 2017.

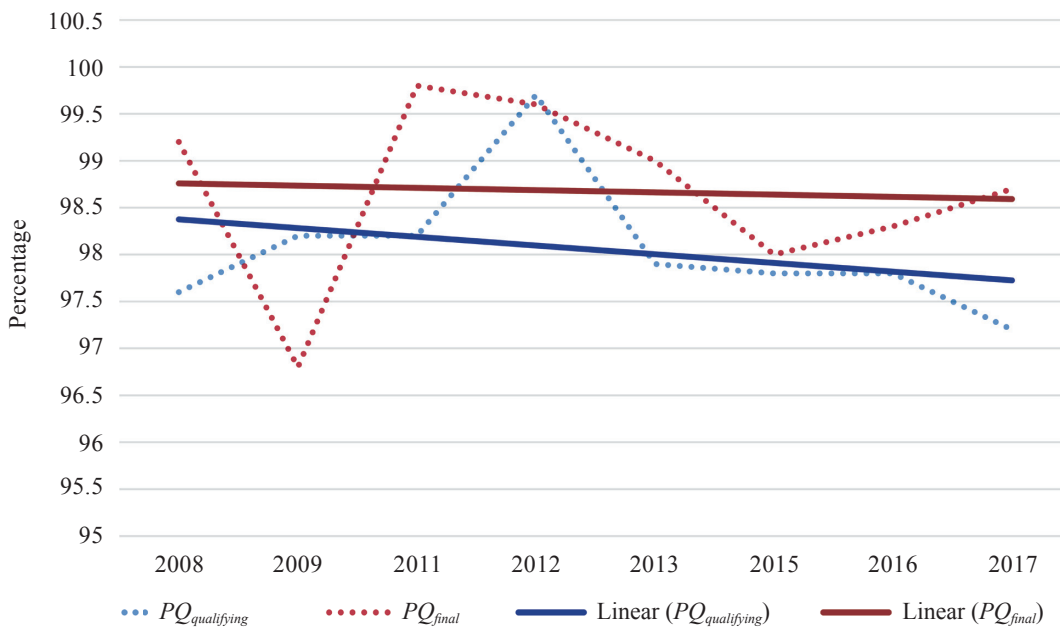

Figure 4. The trend-lines for the performance quotients for the qualifying ($PQ_{qualifying}$) and final (PQ_{final}) rounds.

Table 3.
Correlation Coefficients Between Selected Variables Related to Men's Hammer Performance in the Finals of the Major Championships Between 2008 and 2017

Relationship of correlation	*r*	R^2	*N*	Significance
Distance in *Q* vs. Result in final	.6493	.4222	93	$p < .00001$
Best 3-meet average vs. Result in final	.5682	.3229	93	$p < .00001$
PQ in qualifying vs. *PQ* in final	.5317	.2827	93	$p < .00001$
Seasonal best vs. Result in final	.5244	.2750	93	$p < .00001$
Major championship appearances vs. *PQ* in final	.3196	.1021	93	$p < .01$
Major championship appearances vs. Result in final	.3094	.0957	93	$p < .01$
Seasonal best vs. *PQ* in final	-.2773	.0769	93	$p < .01$
Age vs. *PQ* in final	.2658	.0706	93	$p < .01$
Best 3-meet average vs. *PQ* in final	-.2582	.0667	93	$p < .05$
Distance in *Q* vs. *PQ* in final	.2509	.0630	93	$p < .05$
Age vs. Result in final	.1615	.0261	93	NS
PQ in qualifying vs. Result in final	-.0878	.0077	93	NS

Note. *Q* = qualifying round; *PQ* = performance quotient; NS = not significant.

.01) and the average of the three best competition results of the year leading in to championships (r = -.2582, $p < .05$) and the PQ_{final}. The negative correlations would be expected given that athletes who are performing better going into the major championships would register a lower PQ_{final} compared to an equal performance in the final from a competitor with a lower seasonal best or *X*. Finally, positive correlations were also found for an athlete's age and the PQ_{final} (r = .2658, $p < .01$), and the distance thrown in the qualifying and the PQ_{final} (r = .2509, $p < .05$). No statistical significance was found between a competitor's age (r = .1615) or the $PQ_{qualification}$ (r = -.0878) and the performance in the final.

Discussion

The purpose of this study was to highlight the current performance trends for the men's hammer throw at the major championships over the past 10 years, and to test the significance of selected performance metrics for the event. More specifically, in depth analysis was conducted to uncover significant correlations between selected variables going into the major competitions in order to assess any significant influence they had on performance. A small portion of the overall analysis was conducted to see whether performance in the qualifying rounds would play a significant role in the performance in the final round.

Statistical analysis revealed the distance thrown in the qualifying round did have the highest correlation with performance in the final round of all the variables that were studied (r = .6493). In an analysis of similarly related variables, the relationship between the $PQ_{qualification}$ and the PQ_{final} also displayed statistical significance. This supports the assumption that the competitors who were performing the best, both in terms of *PQ* and actual distance thrown in the qualification rounds, would be more likely to produce the

best results in the final. With regard to variables that might be predictors of success in the finals as one enters the major championship, both the athlete's seasonal best, and average of their three best competition results (*X*) were significantly correlated with performance in the finals. This finding suggests that the competitors that are performing the best during the season will also perform best in the major championships of that year as well.

Previous experience, in the form of number of appearances in major championships, showed a significant correlation ($p < .01$) with performance in the finals in terms of distance thrown and execution (PQ_{final}). The average number of appearances for the finals in the major championships ranged from 3.5 to 7.4 previous appearances, but with a definite decline in average number of appearances from 2013 to 2017. This could suggest a "changing of the guard" with the retirement of some long-time, high-performing throwers during this period (e.g., Koji Murofushi, Primoz Kosmus, and Szymon Ziolkowski). The correlation with experience would be expected since the hammer throw is considered a sport of repetition (Murofushi, Babbitt, & Ohta, 2017), and the peak age for elite performance is usually not achieved until 28 years of age (Babbitt & Saatara, 2014). The period of prime performance for men's hammer throw can extend well past 30 years of age for elite throwers which supports the notion that maturity and experience are closely aligned with top performance (Babbitt, 2016). These findings align with the average age ranges (27.1 to 31.5 years of age) of the major championship hammer finalist competitors in this study by Babbitt.

With regard to age, in and of itself, as a variable for success in the major championships, statistical significance was only found to be positively correlated with execution (PQ_{final}) in the finals ($p < .01$). However, the correlation between age and PQ_{final} ($r = .2658$) was not as high as observed for the number of previous major championship appearances and PQ_{final} ($r = .3196$), thus the results suggested that actual major championship experience may be more important for success than the amount of overall years in the sport. Age and actual throwing distance in the final was not found to be statistically significant which submits that while age may allow for the benefit of more experience, it could also be offset by diminished physical capacity, and therefore, not a significant factor. Finally, performance efficiency in qualifying $PQ_{qualification}$ was also found to be without significance which insinuates that hammer throwers that perform efficiently enough in the preliminaries to get into the final may not necessarily be talented enough to do well in the finals no matter what their level of execution.

Conclusions and Recommendations

In conclusion, this investigation showed that the variables of age, major championship experience, and seasonal performance (both *SB* and *X*) going into the major championship displayed a significant positive correlation with performance in the finals of the major championships. These results support the hypothesis that the factors of age, major championship experience, and seasonal performance would be statistically significant predictors of major championship performance. Given these results, federations may want to take these factors into account when selecting participants for a major

championship in the men's hammer throw. While these may not be the only factors to consider, they could be among the most important when taking all variables into account. Beyond the statistical analysis of the various performance metrics with hammer performance at the major championships, it is striking how the performance trends for the actual throwing results project a downward slope. Since the 2008 Olympic Games, the average performance for the men's hammer finalists in both the qualifying and final rounds has diminished by over 2 m (see Table 1). A corresponding drop of nearly 2 m has also been seen for both the seasonal best and the average for the three best meet results within a given season (see Table 2).

It is very clear that the overall level of elite hammer performance has dropped all together in the last 10 years. Potential causes for this drop could entail the followings: (1) less support for men's hammer throwing from traditionally strong hammer throwing federations, (2) increased and stricter drug testing policies, (3) a retirement of a large number of high-level hammer throwers who have maintained a high standard for a long time, and (4) decreased interest and ability to stay in sport by high-level competitors due to the relegation of the hammer from the Golden/Diamond League, and fewer professional prize money opportunities. Further qualitative research will be necessary to study the comprehensive impact of these variables on men's hammer performance world-wide. It is quite possible that a further decline in men's hammer performance may continue if these developments are to continue. Member federations may want to take into account these trends when making high performance decisions and plan accordingly.

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