

ANALYSIS OF THE DEVELOPMENTAL TRENDS OF RESULTS OF HAMMER THROWERS IN CROATIA FROM 2008 TO 2020: ORIGINAL SCIENTIFIC PAPER

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Abstract

The goal of this research is to determine direction in which these results are heading for both, women and men, in throwing events in Croatia, as well as to recognize the possible factors which have influenced the defined direction in analyzed results. The sample of examines includes all Croatian hammer throwers (N=130) who were ranked in the top 10 in season standings from 2008 to 2020. Research variables were results of male and female hammer throwers. Polynomial regression analysis of 2nd and 3rd degree was used as a primary statistic method to define development direction and result prediction. Development directions of results differ based on gender. Development trends of results in men follow negative direction, while in women they follow positive direction. Prognosis of women indicates high-level results where the best seasonal result reaches entry standard for World Athletics Championships in Oregon 2022 ($\leq 72,50\text{m}$). Average score prognosis of the first 3 seasonal results were close to national entry standard for athletes II. category ($\leq 69,00\text{m}$), while average score prognosis of the first 10 results were close to entry standard for athletes III. category ($\leq 57,00\text{m}$). Prognosis of men show very low value where the best seasonal result was at III. category level. Possible positive effect factors on results: quality coaching based on scientific methods. Possible negative effect factors on results: young throwers population, inadequate investing in hammer throw event or non-existing national role model who would encourage young athletes to start hammer throw training.

Keywords: *hammer throw, male and female throwers, seasonal results, prediction of results*

Introduction

The competitors' results in all sports, as well as in track and field depend on many factors such as athlete's age and gender, athlete's functional and motor abilities, mental preparedness, morphological characteristics, athlete's technical and tactical knowledge, etc. (Ljubičić et al., 2018; Milanović & Harasin, 2004; Pavlović & Radinović, 2010). By analyzing results in throwing events at the world level, factors that affected development trends were determined. Some of them are a dissimilar financial investment in sports, the level of athletes' growth who achieve the best results, the resource availability needed for adequate preparedness of top athletes, the timing of athletes' shape for targeted competitions, and stricter doping controls (Milinović et al., 2013, 2008, 2009; Milinović & Harasin, 2008). The developmental trends of sport results are good indicators of athletes' success or in what condition are certain sports. Due to Croatian athletes' major international success in track and field throwing

events, a need to analyze these results occurs. This paper analyzes developmental trends of results of hammer throw in Croatia. Result analysis of throwing events in Olympic finals in men shows an increase in results in the hammer throw for men from 1968 to 1980s while from 1990s to 2012 London Olympics results were volatile (Cieszkowski & Przednowek, 2015). Women's hammer throw shows an almost linear result increase from 2000 to 2012 which is probably due to the late inclusion of that event in the program of Olympic Games (Milinović et al., 2013). A question arises at which level are results of hammer throw in Croatia at this time, in which direction analyzed results are heading to, do development trends of results differ based on gender, and what these results represent concerning some national and international entry standards and, in the end, what can be expected in the future. The goal of this research is to determine the direction in which these results are heading for both, women, and men, in throwing events

in Croatia, as well as to recognize the possible factors which have influenced the defined direction in analyzed results.

Methods

The sample of examinees includes all Croatian male and female hammer throwers (N=130) who were ranked in the top 10 in national seasonal standings from 2008 to 2020. All data of annual results of Croatian hammer throwers were taken from the official website of the Croatian Athletics Federation. The standards for the 2nd and the 3rd category of Croatian athletes (Cat. II. and Cat. III.) were taken from the official website of the Croatian Olympic Committee, and the entry standards for the World Athletics Championships in Oregon 2022 (WCH) were taken from the official website World Athletics. The research variables were results of male and female hammer throwers. The research examines the development trends of the first seasonal result (SB), the average of first 3 results (AM-1-3) and the average of the first 10 results (AM-1-10) grouped by male (M) and female (F) genders. The collected data were processed by the software package Statistics 14.0. The following descriptive indicators were used to display the results: arithmetic mean (AM), minimum value (MIN), maximum value (MAX), total range (Range), standard deviation (SD). The graphical representations of the results are defined according to the 2nd-degree polynomial regression function model. The predicted values of the results for 2021 and 2022 were obtained by approximating the top 10 results from each season according to the 2nd and 3rd-degree polynomial regression function models.

Results and discussion

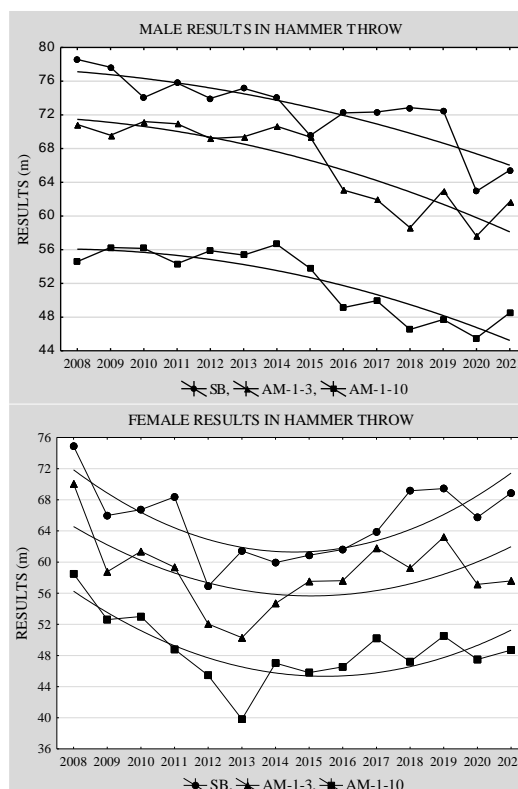
Table 1. Descriptive statistics of the hammer throw results in Croatia from 2008 to 2020.

Variables	Gender	N	AM	MIN	MAX	Range	SD
SB (m)	M	13	73,20	62,94	78,58	15,64	3,89
AM-1-3 (m)	M	13	66,58	57,61	71,21	13,60	4,98
AM-1-10 (m)	M	13	52,45	45,52	56,64	11,12	4,07
SB (m)	F	13	64,99	56,88	74,89	18,01	4,87
AM-1-3 (m)	F	13	58,69	50,29	70,06	19,76	5,02
AM-1-10 (m)	F	13	48,69	39,81	58,50	18,70	4,52

By observing Table 1., relatively high average SB can be seen in both men and women and it's close to the entry standard for Cat. II. (M≥74,00m; F≥69,00m). Maximum values of SB in both genders are also high and they meet entry standards for WCH (M≥77,50m; F≥72,50m). However, referred results in both genders have quite low minimum value and large dispersion

(Range and SD), and following that, very unstable through the observed period and it's very questionable to conclude their value based on current data. By observing average AM-1-10 in both genders, the value of results is very low, and not remotely close to entry standard Cat. III. (M≥64,00m; Ž≥57,00m). This phenomenon already shows that Croatia has a very small number of quality hammer throwers. That could be explained by the very young population in track and field in Croatia which can't be at great international level results. The possibly the most important national competition, Croatian Individual Senior Championships in track and field through last decade (2009-2018) had 25,18% senior men competitors and 36,17% senior women competitors which averages >5 senior men and >3 senior women per event. (Ljubičić et al., 2019). This data indicates that mentioned competitions mostly have younger competitor athletes. Since throwing events have suitable age of 23 to 27 to achieve high results (Bompa, 2009) it can't be expected from younger category (up to 20 are juniors) athletes to achieve senior-level results.

Figure 1. Male and female hammer throw results and the prediction of results according to the 2nd-degree polynomial function regression mode



By observing the lines of result development (Figure 1 and 2), their directions differ based on gender. In men,

the negative direction of all results is shown. Development lines in women results in the observed period of first 4-5 years have exceptionally negative direction and from the satisfactory stage, in the beginning, they reach very low levels in the middle of the observed period. The second half of the observed period gets more positive due to all three development lines which have a more progressive trend and positive direction. Development lines of all results in both genders keep fairly even range amongst them from the beginning of an observed period which in men would mean that all results values have constant decline while in women all results constantly and evenly incline. It's worrying that in both gender lines AM-1-10 from the beginning till the end of the observed period and considering true values is at $\geq 10\text{m}$ distance from the line AM-1-3 indicates a small number of quality men and women hammer throwers in Croatia. Also, SB in men from the beginning of the observed period reached very high values ($>75\text{m}$) which e.g. would be the entry standard for Cat. II. ($\geq 74\text{m}$). Sadly, the same development line of results through the whole observed period has a negative direction and, in its end, reaches much lower values ($<66\text{m}$) which are in the last year only at Cat. III. entry standard ($\leq 64,00\text{m}$). Such development results trend in men indicates crisis period of 5-6 years, and for improvement, there should be a lot of investment to stabilize results at the desired level.

Table 2. The original men's and women's hammer throw results from 2008 to 2020 and the predicted values of results for 2021 and 2022 according to the 2nd-degree polynomial regression function (2021² and 2022²) and 3rd-degree polynomial (2021³ and 2022³).

Gender	MALE			FEMALE		
	SB	AM-1-3	AM-1-10	SB	AM-1-3	AM-1-10
Year	(m)	(m)	(m)	(m)	(m)	(m)
2008	78,58	70,86	54,59	74,89	70,06	58,50
2009	77,65	69,59	56,27	65,98	58,76	52,61
2010	74,06	71,21	56,16	66,74	61,37	53,01
2011	75,77	70,94	54,35	68,36	59,34	48,79
2012	73,95	69,20	55,89	56,88	52,05	45,45
2013	75,15	69,40	55,37	61,44	50,29	39,87
2014	74,04	70,65	56,64	59,94	54,70	47,02
2015	69,55	69,37	53,78	60,88	57,52	45,79
2016	72,24	63,08	49,13	61,61	57,61	46,54
2017	72,35	61,95	49,96	63,88	61,80	50,21
2018	72,86	58,62	46,53	69,16	59,22	47,21
2019	72,51	63,02	47,72	69,44	63,21	50,51
2020	62,94	57,61	45,52	65,75	57,14	47,48
2021	65,43*	61,70*	48,52*	68,87*	57,59*	48,69*
2021 ²	66,62	54,70	42,10	73,90	66,17	53,72
2021 ³	61,69	57,02	44,27	68,44	55,69	47,37
2022 ²	64,60	56,32	43,59	74,83	64,29	53,61
2022 ³	60,30	61,56	49,00	68,40	52,39	46,61

* The result has taken from the current year and there's a possibility it can differ till the end of the running year

The cause of such a negative trend could be lack of interest and insufficient motivation in young athletes for this event just as possible inadequate qualified or educated expert coaching personnel which would develop young men and women hammer throwers to reach quality levels with them. On the other hand, women following analyzed positive trends can be expected to have better results worthy of international level in close future.

By observing the results from Table 2, the most concerning is a gradual decline of men's results from the beginning of the observed period. On the other hand, in women, the lowest value of all results was reached around half of the observed period, but afterward, there's a progression of all results. Such development trend of results in women indicates a „generation shift“, where in this case young perspective throwers stand out. Results prognosis in men are, following the negative trend, and low values mostly expected in 2021 and 2022 concerning the overall observed period, therefore the lowest. The exceptions are prognosis for SB 2021² and 2022², AM-1-3 2022³, and AM-1-10 2022³ that gives hope and indicates the somewhat higher value concerning the previous year (2020). Regardless of mentioned, men's results in hammer throw stay negative because even the best seasonal result is at the Cat. III. level entry standard, ($\leq 64,00\text{m}$) while other results are even weaker. The prognoses of women's results are positive by comparison with men's results, but different models give a different prognosis. By the model of regression function of the polynomial of 2nd degree (2021² and 2022²) predicts progression in all results for 2021 and 2022. Therefore, SB reaches a level above the WCH entry standard ($\leq 72,50\text{m}$), AM-1-3 is close to entry standard Cat. II. ($\leq 69,00\text{m}$), while AM 1-10 is close to Cat. III. ($\leq 57,00\text{m}$). Such prognosis following the positive trend in the last 4-5 years is possible and desirable. However, prognosis by regression function of the polynomial of 3rd degree (2021³ and 2022³) are somewhat cautious with all results so in like 1-3 and AM-1-10 decline of results are to be expected, while prognosis in SB is slightly progressive concerning 2020 and concerning slow decline in the running year.

Conclusion

Development trends of all results in the hammer throw in men end in negative direction while in women they end in a positive direction. A distinction between AM-1-10 and AM-1-3 in both gender is higher than the distinction between SB and AM-1-3. Hammer throw in Croatia currently has high results worthy of the international scene only in women and they are mostly made by individual throwers and have a great impact

on sustaining high-level SB. Precisely SB in women based on prognosis has the most opportunity to progress in 2022 and accordance, to achieve WHC entry standard in that same year. Some of the development factors which could impact negative trends of results development: young throwers population, inadequate investing in hammer throw events, or non-existing national role models who would encourage young athletes to start hammer throw training. Possible factors which impact positive development of individual results: quality coaching based on scientifically studied methods. Prognosis of all results based on models of regression function of a polynomial of 2nd and 3rd degree is realistically possible and feasible but apart from analysis of development trends of results, other factors which could in future positively or negatively impact development trends of results must be considered. For better success, investment in young female throwers should be considered to use the potential of positive development trend of results, just as to motivate them to prevent the downtrend of results or worse, to prevent downtrend of many athletes in throwing events.

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