

Differences of Results between Women's and between Men's Finalists in the Running, Jumping and Throwing Disciplines of the Finalists of the World Championships

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Abstract Background: The Worlds Athletics Championships, along with the Olympic Games, represent the largest review of athletes in which they record top results, often projecting new world records. Any research that analyzes top athletes contributes to shedding light on a number of issues. It is especially interesting to analyze and compare the results of athletes from one time distance. **The main goal** of the research was to determine the result differences in sprint, jumping and throwing disciplines, between men's and women's finalists participating in the World Athletics Championships in Edmonton, 2001 and Doha in 2019. **Methods:** the current study included a total of 493 finalists (247 men's and 246 women's) of the World Championships in Edmonton, 2001 and Doha, 2019. The results in sprint, jumping and throwing disciplines were analyzed in order to determine the result differences in the championship finals. To obtain the necessary information, a t-test for independent samples was applied and the relevant statistical parameters were calculated. **Results:** the results were confirmed between the final evident differences in all disciplines. Men in Edmonton were successful in 41% of the discipline (400m, pole vault, discus throw, hammer throw, javelin throw), and in Doha 59% of the discipline (100m, 200m, 110H, high jump, long jump, triple jump), while in the category of women's finalists, participants in Edmonton were successful in 17% of disciplines (long jump, throwing the ball), while female athletes were successful in 83% of disciplines (100m, 200m, 400m, 110H, triple jump, high jump, high jump with a pole, Throwing a spear, throwing a discus, throwing a hammer). Statistically significant differences between male finalists were recorded only in the disciplines: 200m ($t=2.318; p<0.039$), throwing the ball ($t=-2.939; p<0.009$) and hammer throw ($t=-2.802; p<0.013$), and in female finalists in the 200m disciplines ($t=2.402; p<0.025$), pole vault ($t=-5.552; p<0.000$) and hammer throw ($t=-6.410; p<0.000$). **Conclusion:** the consequences of this distribution of differences finalist can be found in various morphological, motor and biomechanical parameters, technical experience, neuromuscular movements, level of motivation and preparedness at the time of onset and other endogenous-exogenous factors.

Keywords: world championship, finalists, track and field, differences

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1. Introduction

The World Athletics Championships are organized under the auspices of the International Association of Athletics Federations (IAAF). The first World Cup was held in 1983 in Helsinki, when 153 nations with 1573 competitors participated, and the last in Doha, with as many as 209 nations with 1972 competitors. Although not the most massive in terms of the number of competitors, the championship in Doha was rated as the most successful organized athletics championship in all segments. Initially, world cups were held every four years,

and since 1993 every other year. They are held in odd years so as not to coincide in the calendar with another major athletic event, and that is the Summer Olympics. It is considered the third largest sports competition in the world, after the Olympic Games and the World Cup. At the first world championship in Helsinki, 41 disciplines were represented (24 men's and 17 women's), but over time the number increased to 47 (24 men's and 23 women's) [1]. Given that a large number of disciplines are integrated into athletics, the possibility of research and analysis of results is extremely large.

Certain research deals with determining differences in different performances of sprint disciplines. Hunter, Marshall, & McNair [2] test the hypothesis of the most

favorable reaction force on the substrate during the initial acceleration, and the way to achieve it, where the reaction force is defined as a variable. Thirty-six elite athletes collected relevant data during sprint acceleration, which relates to the force produced on the ground. The regression results show that the relative propulsive impulse makes up 57%, and the stopping only 7% of the sprint speed variance. This proves that faster athletes produce moderate magnitudes of relative vertical impulse, while lower magnitudes of relative braking impulse are associated with shorter contact phase distance and more active contact. Also, a higher relative propulsive impulse is associated with the rate of hip extension in the vertical position. Although there is a weak trend for faster athletes to produce lower braking values, braking possibilities that have some advantages are not excluded, so the authors recommend further research to determine whether certain braking, driving and vertical impulses can be modified by certain training. Some research is based on certain changes caused by the introduction of new athletic rules [3], while some examine differences in the performance of the Olympic Games with an emphasis on the time of the starting reaction. Babić & Delalija [4] analyze the start reaction time of sprint and hurdle competitions of participants in the Olympic Games in Athens (through qualifications, semi-finals and finals), which defines their competitive level. Although the result differences are not statistically significant between the competition levels, they were determined in the disciplines of 100m and 400m showing a negative trend, while in the 100m hurdles they showed a positive trend. Based on these findings, reaction time is considered one of the possible determinants of an athlete's competitive quality. A similar research is being conducted by [5] with the aim of determining the differences in the start reaction time of the finalists of the sprint disciplines (100m, 200m, 400m) of the World Athletics Championships in Moscow in 2013. The results of male and female finalists confirm the existence of a statistically significant difference in reaction time between female finalists in the disciplines 100m and 400m ($p < 0.01$), 200m and 400m ($p < 0.01$), in contrast to men where no statistically significant differences are present. Also, no statistically significant differences between the genders were found in the same disciplines. Pavlović, Bonacin, & Bonacin [6] examine the differences in the starting reaction of the male and female finalists of the Olympic Games in Athens '04, Beijing '08 and London '12, where the analysis includes the results in sprint disciplines (100m, 200m and 400m). The obtained results confirm the absence of significant statistical differences in the start reaction time between the male and female finalists in Beijing in the 100m, and in London in the 400m. In men, differences at 100m and 400m were evident for both levels ($p < 0.01$; $p < 0.05$), while in female finalists significant statistical differences were present in all three disciplines ($p < 0.01$; $p < 0.05$).

Authors [7] determine gender differences in the time of the initial reaction and results in the sprint disciplines of the finalists of the Olympic Games in London in 2012. The results of male and female competitors who competed in the final races in the 100m, 200m and 400m were analyzed. The results of the analysis show statistically significant differences in reaction time among female

competitors in the 100m and 400m running disciplines ($p < 0.01$) as well as for the 200m and 400m ($p < 0.01$) disciplines, in contrast to the male finalists where no statistically significant differences. Also, in the same disciplines there are no statistically significant differences between the genders, while the differences are evident in the achieved results (100m ($p < 0.05$), 200m ($p < 0.01$) and 400m ($p < 0.01$)). The differences in the start reaction time are determined [8] with the aim of comparing the finalists of the World Championships in Moscow, 2013 and Beijing, 2015. Applying one-factor analysis of variance of different groups (ANOVA), the obtained results show a significant difference in the results for the discipline 200m for women ($p = 0.008$) and 100m for men ($p = 0.05$), while the gender differences were not confirmed. This speaks in favor of the fact that the reaction time is very variable and cannot be tied to either gender or discipline.

Some studies examine the differences between the starting reaction and the result placement between the finalists of the World Championships and the Olympic Games. Pavlović [9] determines the differences in the start reaction time and the results of the finalists in the sprint disciplines at the Olympic Games in London 2012 and the World Championships in Moscow 2013. The results show statistically significant differences in reaction time between the female finalists of these competitions 100m ($p < 0.001$) and 400m ($p < 0.001$), in contrast to the male finalists where there are significant differences in the 200m ($p < 0.001$) and 400m ($p < 0.001$). Also in the men's final 100m (London) and 200m (Moscow) and 100m (Moscow) and 400m (London) no statistical differences were achieved in the start reaction time. Gürses, & Kamiş [10] examine the relationship between the results of the 60-meter sprint and the reaction time of 483 athletes who participated in the World Indoor Athletics Championships. A positive moderate correlation was found between the mean values of all 60m sprint results and the start reaction time. Significant differences were also found between male and female finalists based on the 60 m sprint time ($p < 0.01$) and the reaction time, respectively ($p < 0.01$). They concluded that the reaction time is of great importance at a performance of 60m. They recommend to trainers and sprinters the possibility of reducing the reaction time in order to achieve better performance than 60m.

In addition to sprint disciplines, performance and their differences in major competitions, some research analyzes the differences of European or world championships in jumping disciplines from a biomechanical aspect. Based on biomechanical parameters, the most successful techniques of the motor structure of competitors can be planned, programmed and detect, and the best model in a given discipline can be designed. Also, based on the data, possible gender differences between jumpers are detect, in order to possibly establish a model and numerical values for both categories of jumpers. In this regard [11] conduct research on male and female long jumpers, finalists of the World Championships in Berlin in 2009 and Daegu, 2011 with the aim of determining same-sex differences in terms of kinematic parameters that are important for achieving good results. Using adequate statistical models, the obtained results show statistically significant differences between male jumpers in second step speed ($p < 0.001$),

third step length, vertical rebound speed and rebound angle ($p < 0.05$), while women differ only in second step speed ($p < 0.05$). Authors [12] are conducting research on a sample of long jumpers, finalists of the World Athletics Championships in Berlin in 2009, with the aim of determining the difference in kinematic parameters between male and female competitors. Results were obtained that confirm statistically significant differences between male and female competitors in favor of men. Differences for the significance level ($p < 0.001$) were identified in the kinematic parameters: section running speed (11m-6m), section running speed (6m-1m), second step speed, first step speed and horizontal rebound speed. Differences in parameters were also identified: the length of the third step, the length of the first step and the vertical rebound speed to the significance level ($p < 0.05$). Only in the kinematic parameters (length of the second step, duration of the rebound phase and angle of the rebound), no statistically significant differences between male and female finalists were confirmed. The aim of the study [13] is to identify the difference between competitors in the jumping disciplines of the European Indoor Championships in Prague. The sample included male and female competitors participating in the qualifications and finals in four jumping disciplines (long jump, triple jump, high jump, pole vault). The results show that 56% of competitors in all disciplines achieved better final results than the qualifiers, while 28% achieved a better result in the qualifications than in the finals. Also, 14% of competitors achieved the same result in both rounds (high jump, pole vault). Significant differences were recorded between qualifiers and finals in the long jump (women) and triple jump (men) disciplines.

Pavlović [14] determines the differences between 11 kinematic parameters, male and female finalists of the World Championship in Daegu, in the high jump discipline. The results obtained by T-test confirm statistically significant differences in 36% of kinematic parameters. Significant differences were recorded in the parameters where the role of velocity and explosive power is mainly manifested: maximum height of the center of gravity of the body ($p < 0.05$), maximum horizontal speed of the center of gravity of the body ($p < 0.05$), horizontal speed of the center of gravity of the body, ($p < 0.05$) and the vertical velocity of the center of gravity of the body ($p < 0.05$). Research [15] analyzes the differences in 22 kinematic parameters in the triple jump discipline, between the female finalists of the 2009 and 2011 World Championships. The results confirm statistically significant differences in 23% of parameters. Women in Berlin have higher values in the bounce angle of the hopper ($p < 0.001$); vertical speed of the jump ($p < 0.001$), duration of the contact phase of the jump ($p < 0.016$), step ($p < 0.011$) and jump ($p < 0.004$), with the average shorter time of the contact phase in all three parameters (jump, step, jump). In both finals, the inverse relationship between the speed and the bounce angle of the competitors was noticed, which is a consequence of the reduction of speed in each jump, where the athletes use a larger swing with their free extremities. An almost identical research [16] was conducted but on a sample of male finalists in Berlin and Daegu with the aim of determining the differences of the relevant kinematic

parameters. Based on the obtained results, differences in the bounce angle were recorded ($p < 0.003$); vertical rebound speed ($p < 0.000$), duration of the contact phase of the rebound ($p < 0.003$), step ($p < 0.000$) and jump ($p < 0.071$). The finalists in Berlin were shown to have a shorter average contact phase time (jump, step, jump) than the finalists in Daegu. Some authors [17] examine the differences of defined kinematic parameters in the discipline Pole vault between male and female finalists of the World Championship Daegu, 2011. A total of nine kinematic parameters were analyzed and the results showed statistical significant differences in 89% of parameters. Significant differences between male and female pole vaulters were recorded in the total run length ($p < 0.01$), number of steps ($p < 0.05$), average stride length ($p < 0.01$), run speed between 11m-6m ($p < 0.01$), the distance between the last step and the pole stab ($p < 0.01$); average length of last steps (15-10m; 10-6m, 6-1m) for men and average length of last steps for women (12-9m; 9-5m, 5-1m).

In addition to studying and identifying differences between the performance of major competitions in sprint and jumping disciplines, some research determine differences in throwing disciplines. Pavlović [18] conducts a study on a sample of 32 male and female finalists in the 2009 and 2011 World Championships, with the aim of determining the differences in the mutual anthropometric and kinematic parameters. Using adequate statistical procedures, differences were recorded in 80% of parameters (ejection speed $p < 0.05$), ejection height ($p < 0.01$), body height ($p < 0.01$), body weight ($t = 7.246$; $p < 0.01$), except in the ejection angle ($p < 0.01$; 0.05). Some authors [19] determine the spatial and temporal differences of kinematic parameters in javelin throw between male and female finalists of the 2009 and 2011 World Championships. The sample included a total of 32 competitors in both categories. The obtained results confirmed statistically significant differences between male finalists in 60% of kinematic parameters: ejection speed ($p < 0.004$), deflection angle ($p < 0.000$), extended step length ($p < 0.028$), distance to ejection line ($p < 0.005$), pulse step duration ($p < 0.001$), spear ejection duration ($p < 0.000$). In women, significant differences were confirmed in 40% of parameters: ejection angle ($p < 0.005$), deflection angle ($p < 0.000$), impulse step duration ($p < 0.001$), ejection duration ($p < 0.001$). In general, this study showed significant differences between male finalists and between female finalists. We should not forget the influence of exogenous factors, primarily air currents and the behavior of the javelin as an aerodynamic device. A slightly different effect of air currents is manifested when throwing hammers, as a consequence of the weight and aerodynamic shape of the device. Hammer throw is a very complex motor throwing discipline with the manifestation of several different forces that try to prevent the rotational movement of the device and the thrower in the projected sagittal plane.

The aim of the study [20] is to determine the spatial and temporal differences of kinematic parameters between male and female finalists, hammer throwers of the World Cup in London, 2017. T-test for small independent samples was applied. The results confirmed differences in most of the measured parameters, while statistically

significant differences between male and female finalists were confirmed only in the amount of ejection ($t = 2.992$; $p < 0.009$). The male finalists threw a hammer on average from a height of 1.74 ± 0.13 m, and the women with 1.54 ± 0.17 m. The study [21] conducted on a sample of Daegu World Cup finalists in 2011, analyzes the differences in kinematic parameters between male and female hammer throwers. The results confirm statistically significant differences between male and female finalists in the speed of ejection of the hammer ($p < 0.004$) and the speed of the fourth turn ($p < 0.002$). The male finalists achieved an average ejection speed of 27.91m/s, with an average turning speed of 4.67m/s, and the female finalists 27.17m/s, with an average turning speed of 4.03m/s. The author concludes that the causes of differences can be found in the length of training, different training process, technical mastery, experience of competitors, morphological profile, motor-anatomical structures, technical and biomechanical parameters that are not included in the study. Badura [22] detects the biomechanical differences between male and female discus throwers of the 2009 World Cup finalists. Ejection parameters (ejection speed, ejection angle, tangent motion tangent, aerodynamic quality, etc.) were analyzed. Spatial and temporal characteristics of throwing movements were obtained by three-dimensional photogrammetric analysis of the best throws for which appropriate images were available. The presented results confirmed the significant differences that were defined as future guidelines for coaches and athletes in preparation for future major competitions. Based on previous research, it is evident that kinematic parameters often have a decisive influence on performance in athletic disciplines, regardless of whether they are sprint, jumping or throwing disciplines. This is very important for top athletes who have almost identical morphological, motor and functional parameters. Often the differences that affect the sports result are attributed to a better performance technique which is a consequence of different values of the kinematic parameters of the individual. Basically, the fact that is evident is that each new world championship brings some new results and successes of competitors in different categories and different disciplines. Precisely on the basis of this information, as well as the nature of previous research, a current study was conducted, realized on a sample of elite athletes in sprint, jumping and throwing disciplines.

The main goal of the research was to determine the result differences in sprint, jumping and throwing disciplines, between men's and women's finalists participating in the World Athletics Championships in Edmonton, 2001 and Doha in 2019.

2. Method

2.1. Participants

All finalists World Championships Edmonton and Doha excluded on the basis of (DQ, DNF, DNS) were not included in this study. With this research included 493 competitors, and that 247 male (120 finalists WCh Edmonton and 127 finalists WCh Doha) and 246 female (122 WCh Edmonton and 124 WCh Doha) participants in

the racing disciplines (100m, 200m, 400m, 110H), jumping disciplines (high jump, long jump, pole vault, triple jump) and throwing disciplines finals (shot put, discus throw, javelin throw, hammer throw). The results are taken from the official IAAF website (www.worldathletics.org/competitions/world-athletics-chaptemps/history).

2.2. Statistical Analysis

Data obtained in the research were analyzed by mean values and standard deviation, and the differences between groups of respondents-finalists were tested using Student's t-test for large independent samples. Statistical analysis was done using the statistical program Statistica 10.0 Soft and the significance level was accepted as 95% ($p < 0.05$); and 99% ($p < 0.01$).

3. Results

The obtained results of the sample of finalists of the world championships are presented in Table 1 and 2. The result differences in both categories of athletes were recorded. In general, in the category of male finalists, participants in Edmonton were more successful in five disciplines with, so to speak, the dominance of throwers (400m, Pole vault, Discus throw, Hammer throw, Javelin throw), while the finalists in Doha were more successful in seven disciplines, with equal dominance of sprint and jumping disciplines (100m, 200m, 110H, Shot put, High jump, Long jump, Triple jump). In the men's finals (Table 1) between the two world championships in the group of sprint disciplines, statistically significant differences in running 200m were recorded. The finalists in Doha achieved a better average result (20.06sec.) than the finalists in Edmonton (20.22sec.), with a result difference of 0.16sec, and confirmed by the test values ($t = 2.318$; $p < 0.039$). Although numerically small difference, in sprint disciplines it is a significant difference because it is about speed (Figure 1). Also, the finalists of the World Championship in Doha were more successful in shot put (21.74m) compared to the finalists in Edmonton (20.83m) by almost 100cm, which is a significant difference confirmed by the test values ($t = -2.939$; $p < 0.009$) (Figure 2). Another throwing discipline where a statistically significant difference was found is hammer throw (Figure 3). Finalists in Edmonton with an average score (79.30m) were more successful than finalists in Doha (76.91m), where statistically significant differences were recorded ($t = 2.802$; $p < 0.013$).

In the category of female competitors (Table 2), the participants in the finals of the World Championships in Doha were superior in results, because they were more successful in ten disciplines (100m, 200m, 400m, 110H, Triple jump, High jump, Pole vault, Javelin throw, Discus throw, Hammer throw), while the athletes in Edmonton were more successful in only two disciplines (Long jump, Shot put). In the women's finals, there were statistically significant differences in the 200m run. The female finalists in Doha were more successful with an average result (22.53sec.). Than the finalists in Edmonton (20.90sec.), where a greater difference was recorded

compared to the male finalists (0.37sec), and confirmed by $t = 2.402$; $p < 0.025$). (Figure 4). Significant differences were recorded in the area of jumps in the discipline of pole vault ($t = -5.552$, $p < 0.000$) where the competitors in Doha were more successful (4.78 m) compared to the finalists in Edmonton (4.46 m) (Figure 5). Another

throwing discipline where a statistically significant difference was recorded is hammer throw (Figure 6). Athletes in Doha threw a hammer of average length (73.43m), which made them more successful than competitors in Edmonton (66.24m), with statistically significant differences ($t = -6.410$; $p < 0.000$).

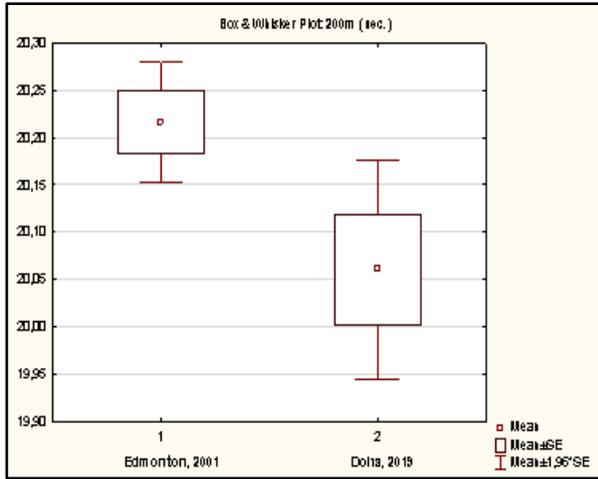


Figure 1.

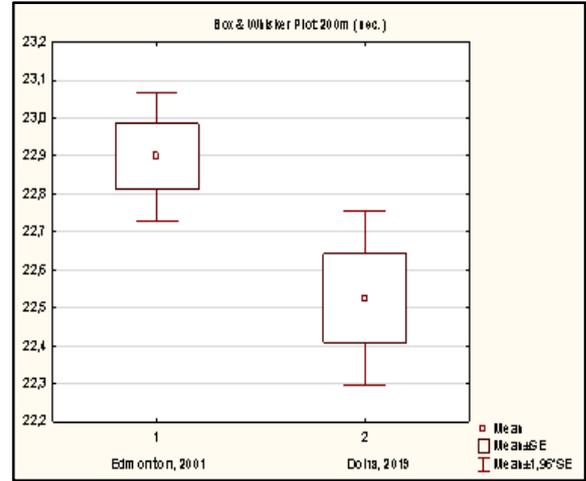


Figure 4.

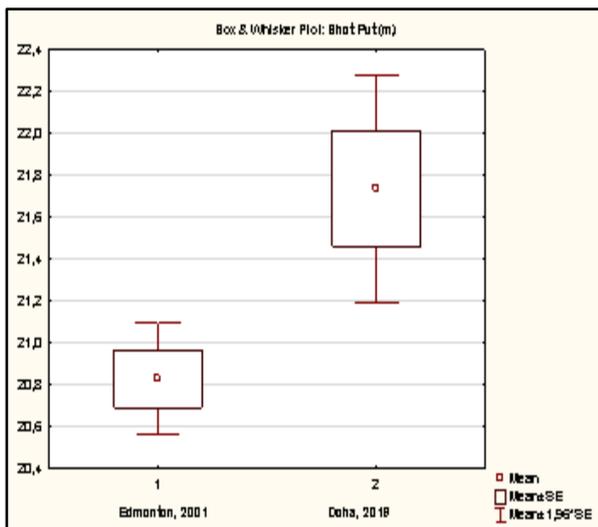


Figure 2.

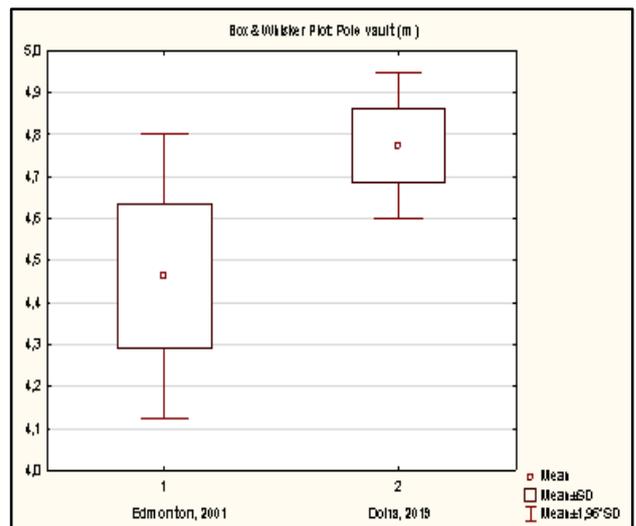


Figure 5.

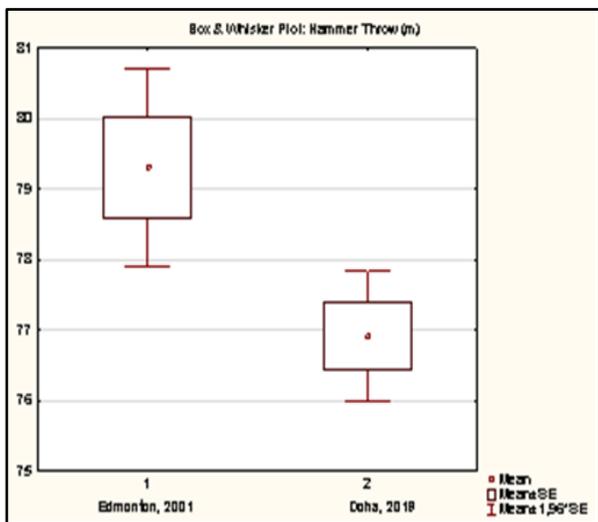


Figure 3.

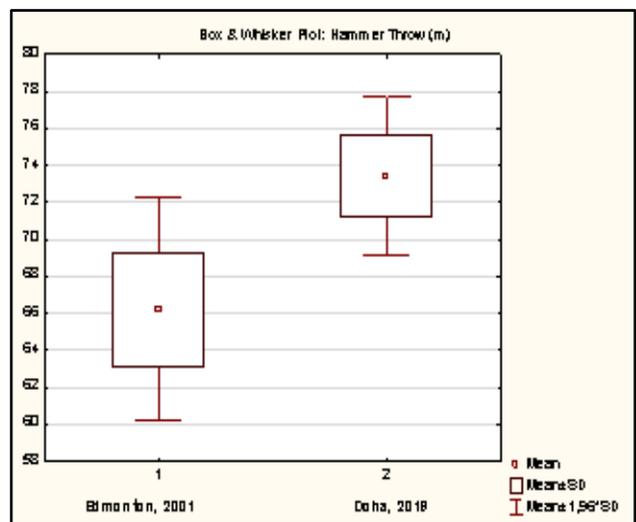


Figure 6.

Table 1. Differences between the male finalists of the World Championships in athletic disciplines

Disciplines	WCh	n	Mean± SD	Mean difference	t-value	p (2-sided)	95% Confidence interval (CI)	
							Lower	Upper
100m	Edmonton	7	9,98±0,102	0,03	0,550	0,590	-0,093	0,155
	Doha	8	9,95±0,107					
200m	Edmonton	7	20,22±0,093	0,16	2,318	0,039*	0,012	0,301
	Doha	8	20,06±0,166					
400m	Edmonton	7	45,18±0,554	0,63	1,935	0,072	-0,080	1,340
	Doha	8	44,55±0,636					
110mH	Edmonton	8	13,41±0,298	0,01	0,077	0,940	-0,302	0,325
	Doha	8	13,40±0,287					
High jump	Edmonton	11	2,27±0,057	-0,02	-0,972	0,343	-0,071	0,025
	Doha	12	2,29±0,053					
Pole vault	Edmonton	11	5,77±0,137	0,06	1,043	0,308	-0,064	0,190
	Doha	12	5,71±0,155					
Long jump	Edmonton	11	8,03±0,240	-0,12	-1,121	0,277	-0,346	0,103
	Doha	12	8,15±0,278					
Triple jump	Edmonton	12	16,93±0,553	-0,12	-0,427	0,676	-0,696	0,459
	Doha	12	17,05±0,791					
Shot put	Edmonton	10	20,83±0,457	-0,91	-2,939	0,009**	-1,554	-0,263
	Doha	12	21,74±0,919					
Discus throw	Edmonton	12	65,53±3,087	0,36	0,352	0,729	-1,774	2,499
	Doha	12	65,17±1,792					
Hammer throw	Edmonton	12	79,30±2,465	2,39	2,802	0,013*	0,619	4,154
	Doha	12	76,91±1,624					
Javelin throw	Edmonton	11	84,95±4,747	3,1	1,832	0,078	-0,428	6,617
	Doha	12	81,85±3,130					

Note: *p<0.05; **p<0.01.

Table 2. Differences between the female finalists of the World Championships in athletic disciplines

Disciplines	WCh	n	Mean± SD	Mean difference	t-value	p (2-sided)	95% Confidence interval (CI)	
							Lower	Upper
100m	Edmonton	6	11,02±0,133	0,07	0,853	0,405	-0,110	0,250
	Doha	7	10,95±0,158					
200m	Edmonton	6	22,90±0,213	0,37	2,402	0,025**	0,035	0,710
	Doha	7	22,53±0,329					
400m	Edmonton	7	50,56±0,762	0,77	1,471	0,156	-0,360	1,894
	Doha	7	49,79±1,178					
100mH	Edmonton	8	12,67±0,189	10,11	1,124	0,280	-0,099	0,313
	Doha	8	12,56±0,178					
High jump	Edmonton	12	1,93±0,047	-0,03	-1,10	0,282	-0,070	0,021
	Doha	12	1,96±0,026					
Pole vault	Edmonton	12	4,46±0,173	-0,32	-5,552	0,000**	-0,429	-0,196
	Doha	12	4,78±0,089					
Long jump	Edmonton	12	6,75±0,189	0,06	0,591	0,558	-0,143	0,258
	Doha	12	6,69±0,276					
Triple jump	Edmonton	12	14,23±0,437	-0,25	-1,426	0,169	-0,602	0,112
	Doha	12	14,48±0,406					
Shot put	Edmonton	12	19,06±0,757	0,37	1,338	0,196	-0,205	0,945
	Doha	12	18,69±0,592					
Discus throw	Edmonton	12	61,76±3,809	-1,37	-0,891	0,383	-4,586	1,836
	Doha	11	63,13±3,574					
Hammer throw	Edmonton	12	66,24±3,064	-7,19	-6,410	0,000**	-9,527	-4,858
	Doha	11	73,43±2,205					
Javelin throw	Edmonton	12	61,96±3,564	-0,06	-0,042	0,969	-3,048	2,935
	Doha	12	62,02±3,503					

Note: *p<0.05; **p<0.01.

4. Discussion

Each World Athletics Championships spawns some new young talented athletes, new records, new equipment that aims to boost results and win medals. In terms of result success, each "Launch" championship records new results of athletes in a large number of athletic disciplines, both in men's and women's competition. It is also often recorded the progress of the achieved results as a result of different training technologies as well as the differences between the achieved results which are archived, compared and analyzed as an aid in the future projection of the training process. Given that a large number of disciplines are integrated in athletics, the possibility of research and analysis of results is extremely large.

The current research was conducted on an elite sample of top athletes in order to determine the differences in sprint, jumping and throwing disciplines between women's and men's finalists of two world championships (Edmonton, 2001 and Doha, 2019). The results confirmed the differences in all athletic disciplines between the two championships. Men in Edmonton were more successful in 41% of disciplines (400m, pole vault, discus throw, hammer throw, javelin throw), and in Doha 59% of disciplines (100m, 200m, 110H, High jump, long jump, triple jump). In the women's finalists category, participants in Edmonton were more successful in only 17% of disciplines (Long jump, Shot put), and female athletes in Doha were more successful in 83% of disciplines (100m, 200m, 400m, 110H, Triple jump, High jump, Pole vault, Javelin throw, Discus throw, Hammer throw). Statistically significant differences between male finalists were recorded in the disciplines: 200m ($t = 2.318; p < 0.039$), shot put ($t = -2.939; p < 0.009$) and hammer throw ($t = -2.802; p < 0.013$), and in female finalists in the 200m disciplines ($t = 2.402; p < 0.025$), pole vault ($t = -5.552; p < 0.000$) and hammer throw ($t = -6.410; p < 0.000$). Only in the disciplines of jumping, no differences were recorded, which are also statistically significant in both categories of athletes.

The question is the presence and influence of certain factors in the recorded result differences. When it comes to the 200m discipline, it is considered that certain biomechanical factors, the so-called propulsive impulse, which was confirmed by research [2] by examining the hypothesis of the most favorable reaction force on the substrate during the initial acceleration, and the way to achieve it. Another very important factor is the level of speed endurance of athletes, which is increasingly paid attention during the training process, running techniques, and arises as a product of certain anaerobic processes in the body and good neuromuscular coordination, which was present in shorter sections [10]. The best examples of speed endurance are the C. Lemmetre and U. Bolt sprinters. Significant influence is taken by the better time of the initial reaction, which is relative, but still has a share in the final result, which is in line with the results of [4]. They consider the reaction time to be one of the possible determinants of the competitive quality of athletes. However, there are conflicting opinions. That the reaction time is relative and often not a decisive factor in the result success is confirmed by the research results [5,9] or very often the difference in results depends on the

gender of competitors [6,7]. The obtained results of this research are in accordance with the research [8] who believe that the reaction time is very relative and cannot be related to either gender or discipline. The results of the current research confirmed the presence of differences between the jumping disciplines, which were not statistically significant in the male sample, while pole vault in the female finalists differed in the results between the two championships. Probable causes can be found in the successful technical performance and various biomechanical parameters that define the movement technique. Pole vault is a specific discipline that, in addition to relevant biomechanical parameters, also takes into account the pole as an external prop and its successful manipulation in time and space. In that case, the neuromuscular coordination and control of the athlete comes to the fore, taking into account the synchronized realization of a large number of kinematic parameters. In general, these parameters differ depending on the gender of the competitors, their motor and technical experience, which is confirmed by the results of the research [17]. Identical conclusions that support the results of this research apply to the so-called long jumps (long, triple jump) which record significant differences in kinematic parameters, and are predictors of good results, and possible differences in running speed on a given section during the run, lengths of the first, second and third step, bounce duration, vertical speed, bounce angle, etc. [11,12,15]. Similar differences apply to the results obtained in high jump, most often in the parameters of individual movement speed and explosive power, which significantly saturate in kinematic parameters (maximum height of the center of gravity, maximum horizontal speed of the center of gravity, horizontal speed of the body and vertical speed center of gravity of the body). All these parameters have a significant impact on the result success [14,15,16], which can be a significant indicator in the distribution of differences in the results of current research from the aspect of jumping disciplines.

In terms of the result differences in the throwing disciplines of the world championships, the result differences in shot put and throwing the hammers of the men and throwing the hammers of the female finalists are evident. Both disciplines significantly exclude the influence of air flow and device shape on the result. The success is mainly based on the parameters of the morphological and motor profile of the thrower as well as the kinematic parameters of speed, height and throwing angle, which is in line with the statements of some authors [18] who analyze the finalists in shot put in Berlin and Daegu. It is almost identical in hammer throw where the air flow has no effect on the resultant success as a consequence of the weight and aerodynamic shape of the device. Hammer throw is a very complex motor throwing discipline with the manifestation of several different forces that try to prevent the rotational movement of the device and the thrower in the projected sagittal plane. Research by [20] on the sample of finalists of the championship in London shows the existence of differences in kinematic parameters by gender, with isolated ejection height which confirmed the statistical significance, where male finalists throw a hammer from

an average height of 1.74 cm height 1.54cm. In the current research, it can be concluded that the height of the ejection followed by the speed of rotation (more than 4.5 m/s) and the ejection speed (higher than 27 m/s) has an impact on the overall result, which is in line with the results of the [21]. The resulting differences between the throwing of the ball and the hammer of male and female finalists can be found in the length of training, different training process, technical mastery, experience of competitors, morphological profile, motor and anatomical structures, technical and biomechanical parameters. Identical conclusions can be drawn when it comes to the result differences in javelin throwing and discus throwing. In addition to the influence of different temporal and spatial kinematic parameters in these two disciplines [22], a significant influence is exerted by the air flow, especially when throwing a spear, while the disk manifests speed, angle, tangent, etc. [19] which can also be a decisive factor in the result success and the differences between the finalists between these two championships.

5. Conclusion

The obtained research results in different disciplines of the World Athletics Championships (sprint, jumping, throwing) are sometimes without identified differences in the defined problem and goal of the research, and sometimes statistically different.

Previous research included an analysis of the results of male and female finalists in the athletic disciplines of the World Championships in Edmonton and Doha, with the aim of determining the difference in results. Male in Edmonton were more successful in 41% of disciplines and in Doha in 59% of disciplines. In the female finalists category, participants in Edmonton were more successful in 17% and female athletes in Doha in 83% of disciplines. Statistically significant differences between male finalists were recorded only in the disciplines: 200m ($t=2.318$; $p<0.039$), throwing the ball ($t=-2.939$; $p<0.009$) and hammer throw ($t=-2.802$; $p<0.013$), and in female finalists in the 200m disciplines ($t=2.402$; $p<0.025$), pole vault ($t=-5.552$; $p<0.000$) and hammer throw ($t=-6.410$; $p<0.000$). Given the fact that they are elite athletes, participants in the championship finals, the consequences of this distribution of differences can be found in various morphological, motor and biomechanical parameters, technical experience, neuromuscular movements, level of motivation, self-confidence, mental stability, competition conditions, level of preparedness at the time of onset and other endogenous-exogenous factors.

Conflict of Interest

The authors declare no conflict of interest.

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