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Analysis of artistic swimming technical element scores at the Tokyo 2020 Olympic Games

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Abstract

The aim of the research is to analyze the duet and team competition performances by examining the technical routine element scores of the artistic swimmers in the Tokyo 2020 Olympic Games. The official results of Tokyo 2020 artistic swimming element scores are reviewed. Duet and team element scores were compared with each other. The element scores of the countries participating in the competitions were ranked from the highest to the lowest and analyzed statistically. The duet and team element scores of Tokyo 2020 and the last three world championships were compared. Tokyo 2020 element scores were found to be similar to each other. There was a significant difference between the element score rankings of the countries ($p<0.01$). The 3rd element score in the duet was statistically significantly lower ($p<0.05$). In the team, the 2nd element score was significantly lower and the 3rd element score was significantly higher ($p<0.05$). There is a significant difference in the duet between the element point averages of Tokyo 2020 and the last three world championships. In the team, there is a similarity between the element scores. The Tokyo 2020 artistic swimming element scores are higher than the averages in the last three world championships.

Keywords: Artistic swimming, artistic swimming elements, duet, team, Tokyo 2020

Introduction

Artistic swimming is one of the six sports branches affiliated to World Aquatics. Artistic swimming is an aesthetic sport and includes technical skills in the water, proper body position, synchronization, and choreographies made with music with artistic elements (Mountjoy, 1999). According to the competition types determined by World Aquatics, there are solo, duet, mixed duet, team, free combination and highlight programs in artistic swimming today (Fédération Internationale de Natation, 2018; Fédération Internationale de Natation, 2021). Solo, duet, mixed duet and team competition categories have two race types, both technical and free. The first world championship of artistic swimming was held in 1973. Artistic swimming, then known as synchronized swimming, was accepted into the Olympic Games in 1984 (Lundy, 2011; FINA, 2021). Today, only duet and team competitions are held in the Olympic Games (FINA, 2021).

Two athletes can compete in the duet category and eight athletes can compete in the team category. According to World Aquatics rules, only female athletes can compete in duet and team competitions. For this reason, only female athletes can take part in artistic swimming of the Olympic Games. Studies have been carried out on the difficulty levels of the movements and transition forms between the movements in artistic swimming. In this way, there are difficulty values of the movement transitions that make up the artistic swimming figures and elements. Evaluations made in competitions are scored according to these difficulty levels (FINA, 2018).

In the evaluation of technical elements, it has been understood that the video analysis method is useful for artistic swimming referee training. The use of videos is effective in the training of referees to explain the correct technical evaluations. Visual education methods are considered to be a reliable tool (Ponciano et al., 2018). It has been emphasized that artistic swimmers can provide effective functional adaptation in applications involving low volume and high pressure (Coates et al., 2021). In terms of the technical development of the athletes, the follow-up of the choreographic performances made with the elements is one of the studies considered necessary for adaptation. It is explained that there is little information about artistic swimming training and athlete development process. Although there is information about certain subjects, there are not enough studies on the effect of artistic swimming performance and physical and physiological correlations on scoring (Viana et al., 2019).

Elements in technical routines of artistic swimming are determined by the World Aquatics Artistic Swimming Technical Committee for a period of four years. According to the artistic swimming rules, the elements in the technical program competitions must be made following the order determined by the World Aquatics Artistic Swimming Technical Committee. The methods applied in the evaluation of the performances of the athletes in the competitions are determined by the same committee. Accordingly, there are five referees for element evaluations in the competitions in the Olympic Games. The highest and lowest points awarded by the referees are eliminated. The average of the remaining 3 points is taken and multiplied by the difficulty value of that element. The result is only one element score, and the same method is applied for a total of 5 elements. Then, the score of 5 elements is summed and 40% is determined to add to the total score of the competition (FINA, 2018).

It is aimed to examine the element scores in the technical routine of the 2020 Olympic categories in artistic swimming in terms of movement characteristics. It is aimed to obtain statistical data in duet and team competitions by examining the technical routine element performances of artistic swimmers in the Olympic Games in depth. Examining the elements that are mandatory movements in artistic swimming in terms of athlete performance is

important for the development of competition scores. The performances of the elite athletes who had the right to participate in the Olympic Games were compared in terms of points according to the movements in the elements. In this way, the relationship between the difficulty level of the element and the transition movements in it and the scores of the athletes was determined. It is thought that the research will enable the creation of score targets for each element group in terms of athlete development.

Material and Method

Research Model

The study was prepared according to the single scanning model within the scope of quantitative research. It is stated that researches are carried out to determine the variables as a single type or amount in the single screening model (Karasar, 2020).

Study Group

First of all, the elements of artistic swimming senior technical routine were examined. Since duet and team competitions take place in the Olympic Games, only the elements in these two categories have been examined. Elements are analyzed in terms of the number of transitions and difficulty level, according to the specifications specified in World Aquatics's artistic swimming rulebook. According to the rules of artistic swimming, there are 5 duet elements and 5 team elements. The difficulty level of the elements and the number of movement passes are given in table 1. Element competition scores in the artistic swimming duet and team technical routines of the Tokyo 2020 Summer Olympic Games were used to analyze the competition performances. The 2015, 2017 and 2019 world championships element scores of the same competition categories were also examined. The competition scores of the athletes were obtained from the official results of the Olympic Games (International Olympic Committee, 2021; FINA, 2021).

Table 1. Difficulty levels of elements for the periods 2013-2017 and 2017-2021

	2013-2017		**2017-2021**	
Elements	**Transition movements**	**Degrees of Difficulty (DD)**	**Transition movements**	**Degrees of Difficulty (DD)**
Duet 1	4	3.1	3	2.3
Duet 2	3	1.9	7	2.9
Duet 3	2	2.1	3	2.8
Duet 4	5	2.8	6	3.0
Duet 5	3	2.4	4	2.5
Total		**12.3**		**13.5**
Team 1	2	1.8	4	2.5
Team 2	3	2.4	2	2.2
Team 3	5	2.9	5	2.6
Team 4	4	2.5	8	3.1
Team 5	4	1.7	4	2.5
Total		**11.3**		**12.9**

Data Collection Instruments

Before starting the research, the ethics committee approval was obtained by the Ethics Committee of Istanbul Esenyurt University by 2022/10-3 on 11.11.2022. When we look at the element properties and the order of application in the 2013-2017 and 2017-2021 periods, it is understood that the element order is similar except for one change. It was seen that the movement structure, which includes only the 4th element of the team for the period of 2013-2017, was made in the 5th place in the team elements of the period of 2017-2021 (FINA, 2015; FINA, 2018).

The 5 element scores of the technical routine in the Tokyo 2020 Summer Olympic Games artistic swimming duet and team competitions were compared with each other. According to the Tokyo 2020 quota, 22 countries took part in the duet and 10 countries took part in the team. However, the athletes of 1 country whose Covid-19 tests were positive were withdrawn from the competition. For this reason, the technical routine results of 21 countries in the duet and 9 countries in the team were examined. In order to rank the element scores, the 5 element scores of each country were ordered from the highest to the lowest, and the relationship between difficulty levels and high scores was examined. For this, the element with the highest score is arranged in the 1st place and the lowest score in the 5th place. The same method was applied for the element scores of all countries participating in the competition. In this way, the element score ranking of the countries was created. Comparisons were made to determine in which order the elements took place in the scoring. For this, groups of 5 elements were formed. According to the order of the element score of the countries, which element is in which rank is written according to the groups.

In order to evaluate the general performance characteristics of the Tokyo 2020 Summer Olympic Games artistic swimming competition results, the results of the world championships held in the Olympic categories between 2015 and 2020 were examined. The official results of the world championships held between these dates in 2015, 2017 and 2019 were used. Since the artistic swimming competition times and scoring system are the same in the 2013-2017 and 2017-2021 periods, the world championships including these dates were preferred. The same method described above for the artistic swimming technical routine of the Tokyo 2020 Summer Olympic Games was applied to the world championships. In addition, the Tokyo 2020 results and the average scores of the 3 world championships examined were compared in two groups.

Data Analysis

Element groups prepared for statistical analysis do not show normal distribution. Therefore, the scores of the 5 elements were compared using the Kruskal Wallis test. In order to perform a statistical analysis of the element score order, the groups were first compared with each other using the Kruskal Wallis test, and then each element was compared with the other one by one with the Mann-Whitney U test. Tokyo 2020 results and the results of the world championships were used for statistical analysis by using the Mann-Whitney U test, one of the non-parametric tests, since the variables do not show normal distribution. SPSS 26.0 statistical program was used for the analysis.

Findings

The findings of the research should be given in this section. Tables, figures, and graphics, if any, should be explained by giving examples.

Tokyo 2020 Summer Olympic Games duet and team element scores were compared. According to the statistical analysis, it was understood that the scores obtained in the competitions were similar in both duet and team categories ($p>0.05$). In Table 2, the results of the Kruskal Wallis test used to compare the duet and team scores are given.

Table 2. Comparison of element scores

		Groups	n	Mean ± S.D.	sd	X^2	p
Tokyo 2020	**Duet**	1. element	21	8.58 ± 0.63	4	0.434	0.980
		2. element	21	8.60 ± 0.62			
		3. element	21	8.51 ± 0.70			
		4. element	21	8.56 ± 0.66			
		5. element	21	8.57 ± 0.62			
	Team	1. element	9	8.96 ± 0.72	4	1.226	0.874
		2. element	9	8.85 ± 0.72			
		3. element	9	9.01 ± 0.73			
		4. element	9	8.98 ± 0.75			
		5. element	9	8.94 ± 0.78			

The element scores of the countries are listed in order from highest to lowest. The high score ranking number of each element according to the countries has been determined. Thus, it was understood which of the duet and team elements got higher scores. Statistical analysis was performed to understand the difference and similarity in score ordering between the elements (Table 3). It has been determined that there is a difference between the order of duet and team elements. In this way, it was understood that some elements were generally scored higher ($p<0.01$). Looking at the ranking averages, it was understood that the countries scored the highest in the 2nd element in the duet and the highest in the 3rd element in the team (Table 3).

Table 3. Comparison according to the ranking of the element scores of the countries within themselves

		Groups	n	Mean ± SS.	sd	X^2	p
Tokyo 2020	**Duet**	1. element	21	2.62 ± 1.36	4	17.880	0.001*
		2. element	21	1.86 ± 1.01			
		3. element	21	3.81 ± 1.40			
		4. element	21	2.62 ± 1.53			
		5. element	21	2.62 ± 1.47			
	Team	1. element	9	2.78 ± 1.09	4	21.030	0.000*
		2. element	9	4.44 ± 1.33			
		3. element	9	1.44 ± 0.73			
		4. element	9	2.33 ± 1.00			
		5. element	9	3.11 ± 0.93			

*($p<0.01$)

The Mann-Whitney U test was used to determine which element scores were similar and different from other elements (Table 4). Accordingly, it was found that the lowest score among the elements in the duet was obtained in the 3rd element and there was a significant difference between the others in terms of ranking ($p<0.05$). As can be seen from the averages in Table 3, it is understood that the 3rd element is more in the top ranks due to its high score, and the 2nd element is more in the last place in the rankings due to its low score. Therefore, it

was found that there was a significant difference in the rankings of the 2nd and 3rd elements in the set with the others ($p<0.05$).

Table 4. Comparison of element scores with each other in order from high to low

	Duet					Team				
Elements	**n**	**Mean Rank**	**U**	**Z**	**p**	**n**	**Mean Rank**	**U**	**Z**	**p**
1. element	21	24.88	149.500	-1.860	0.063	9	6.11	10.000	-2.799	**0.006**
2. element	21	18.12				9	12.89			
1. element	21	16.62	118.000	-2.641	**0.008**	9	12.56	13.000	-2.541	**0.014**
3. element	21	26.38				9	6.44			
1. element	21	21.62	218.000	-0.065	0.948	9	10.56	31.000	-0.870	0.436
4. element	21	21.38				9	8.44			
1. element	21	21.60	218.500	-0.052	0.959	9	8.83	34.500	-0.555	0.605
5. element	21	21.40				9	10.17			
2. element	21	14.10	65.000	-4.012	**0.000**	9	13.33	6.000	-3.241	**0.001**
3. element	21	28.90				9	5.67			
2. element	21	18.71	162.000	-1.545	0.122	9	13.06	8.500	-2.932	**0.003**
4. element	21	24.29				9	5.94			
2. element	21	18.45	156.500	-1.683	0.092	9	12.44	14.000	-2.480	**0.019**
5. element	21	24.55				9	6.56			
3. element	21	26.10	124.000	-2.497	**0.013**	9	7.17	19.500	-1.974	0.063
4. element	21	16.90				9	11.83			
3. element	21	26.17	122.500	-2.534	**0.011**	9	5.72	6.500	-3.134	**0.001**
5. element	21	16.83				9	13.28			
4. element	21	21.45	219.500	-0.026	0.979	9	7.67	24.000	-1.544	0.161
5. element	21	21.55				9	11.33			

($p<0.05$)

In Figure 1 and Figure 2, the distribution of countries in Tokyo 2020 and the last three world championships by continents is given. The distribution of countries examined in the world championships was determined as the number of Tokyo 2020 quotas. Normally, the number of countries participating in world championships is higher. Since 21 countries in the duet and 9 countries in the team could complete the Tokyo 2020 artistic swimming competitions, the same number of duets and team scores were examined in the world championships. It has been understood that the distribution of the countries in the Olympic Games has changed due to the continental quotas.

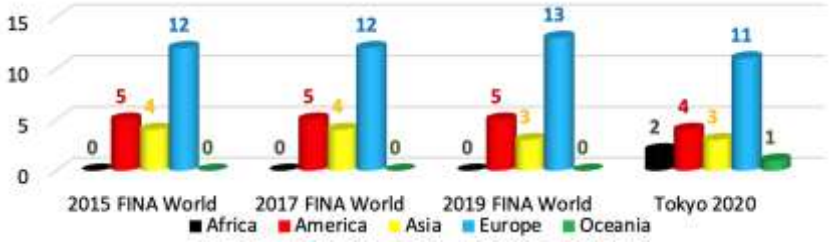

Figure 1. Distribution of countries in duet Tokyo 2020 and the last 3 world championships by continents

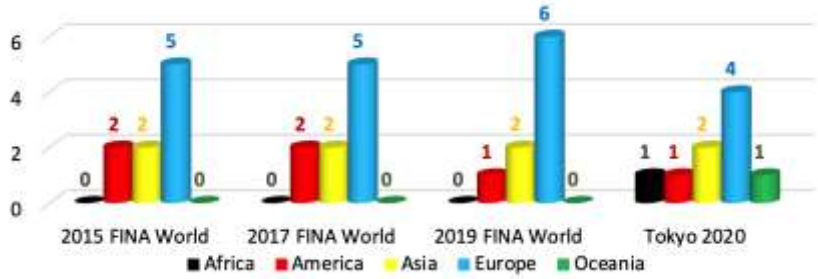

Figure 2. Distribution of countries in team Tokyo 2020 and the last 3 world championships by continents

When Tokyo 2020 and the last three world championship elements are compared in Table 5, it is understood that there is a significant difference between the duet scores (p>0.05). The same similarity was found between the team scores (p>0.05).

Table 5. Tokyo 2020 and last three world championship element scores

	Variable	N	Mean Rank	U	Z	p
Duet	1 – 5 element in Tokyo 2020	21	119.67	4025.000	-3.379	0.001
	1 – 5 element in last 3 world champ. mean	21	91.33			
Team	1 – 5 element in Tokyo 2020	9	49.23	844.500	-1.356	0.175
	1 – 5 element in last 3 world champ. mean	9	41.77			

(p<0.01)

Statistical analysis was carried out in order to understand which element scores in the duet were different or similar to each other. Accordingly, the scores of artistic swimming elements with similar structures in terms of movement characteristics were compared (Table 6). It was found that there was a similarity in the one-to-one analysis of all element scores (p>0.05). However, a significant difference was observed when all of the elements were evaluated as one (Table 5).

Table 6. Comparison of duet element scores of similar structure

Variable	n	Mean Rank	U	Z	p
1st element in Tokyo 2020	21	23.71	174.000	-1.170	0.242
1st element in last 3 world champ. mean	21	19.29			
2nd element in Tokyo 2020	21	25.00	147.000	-1.849	0.064
2nd element in last 3 world champ. mean	21	18.00			
3rd element in Tokyo 2020	21	24.33	161.000	-1.497	0.134
3rd element in last 3 world champ. mean	21	18.67			
4th element in Tokyo 2020	21	24.26	162.500	-1.460	0.144
4th element in last 3 world champ. mean	21	18.74			
5th element in Tokyo 2020	21	24.29	162.000	-1.472	0.141
5th element in last 3 world champ. mean	21	18.71			

Discussion and Conclusion

In terms of athlete development, it is thought that it will be beneficial to study the figures commonly used in artistic swimming in training. Recognition of the figures and a good understanding of their movement characteristics are recommended. It is recommended for performance improvement to use artistic swimming figures and movement transitions, which are widely used according to the age groups of athletes in training (Akgün, 2020). Working the basic movement structures that make up the elements from an early age provides benefits for the technical development of the athletes. It is important to be technically well-developed in order for athletes to score high in competitions involving elements. The fact that the athletes learn all the figure structures in the elements from an early age contributes to the ranking of the countries. Many basic movement transitions and figures in artistic swimming are included in the elements. For this reason, the successful performance of the basic movements of the athletes contributes to the good performance of more than one element.

In the study conducted on duet and team athletes, which are the Olympic competition categories of artistic swimming, the average age of the 2007-2019 FINA World Aquatics Championships were examined. Accordingly, it was understood that the average age of the athletes increased as the competition ranking increased. According to the results of the research, it was found that female athletes have an average age of 25 years in a duet and 23 in a team. It has been stated that the age variable of artistic swimming athletes is one of the important factors in the success of competition performance (Akgün, 2021). The importance of the age factor in the improvement of element performances in technical routines is understood. Since it is necessary to be well-developed technically in order to have high element scores, age-related technical skill is taken into account.

Schaal et al. (2013) investigated the physiological responses to repeated maximum performance training specific to elite artistic swimmers. Autonomic and metabolic recovery levels and repeated second competition performance of the athletes after the competition performance applied in the training were examined (Schaal et al., 2013). Intense dynamic exercise and prolonged and repetitive apnea processes are involved during artistic swimming routines (Rodríguez-Zamora et al., 2013; Zamora, 2013). It is understood that elements and figure structures containing them are also included in the performances of the athletes examined. The physiological responses created by the element movements in the athletes are among the factors that directly affect the scoring. It is important to examine physiological responses for technical development in element studies of athletes.

The technical team and free team routines of artistic swimmers were examined according to blood lactate concentration. During routines, phosphocreatine stores and aerobic metabolism are the dominant energy sources. It has been described that athletes' blood lactate concentration levels tend to increase during both technical and free routines. In competition routines, phosphocreatine stores and aerobic metabolism are dominant in the first section of the technical team and in the middle section of the free team. Depending on the energy requirement, glycolysis can be used in the last part of the routine (Yamamura, Matsui,

Kitagawa, 2000). In this study, the technical and free team competition times are longer than today. Therefore, Yamamura et al. (2000) it is thought that it would be more accurate to consider the first and middle parts of team routines in the results of their research.

Schaal et al. (2015) state that they support the daily use of whole-body cryostimulation to reduce overload during key periods of competition preparation. The use of whole-body cryostimulation during intense training helped alleviate functional overloads such as reduced sleep, increased fatigue, and impaired exercise capacity observed (Schaal et al., 2015). It has been stated that the artistic swimming duet competition performance during the training is almost the same as the competition situation in the real competition environment. Therefore, to increase cardiovascular fitness for the necessary fitness development of elite artistic swimmers; Ensuring the automaticity of the choreographic movements contributes to supporting the coordination and artistic artistic expressions among the team athletes (Zamora, 2013). Athletes in the same team must be at a similar technical level. For this, it is obligatory for the athletes to perform the duet and team elements at the same level as per the competition rules. World Aquatics has decided to make some changes in artistic swimming at the end of 2022. Accordingly, the scoring system was changed, but the difficulty values of artistic swimming movements remained the same. There was no change in the properties of the obligatory movements, that is, the elements examined within the scope of the research. It is possible to consider the research findings in the preparation of athletes for the new scoring system (World Aquatics, 2023).

As a result of the research, the element scores in the Tokyo 2020 Olympic Games artistic swimming technical routines were compared with the scores in the 2015, 2017 and 2019 world championships of the same competition types. Thus, the athletes' world championship element performance levels and their similarity to the scoring in the Olympic Games were tested. It has been understood that the distribution of points between the Tokyo 2020 duet elements of the athletes is similar. It has been observed that the same situation is valid for team elements as well. According to the countries, it was understood that the 2nd element score was the highest among the Tokyo 2020 duet element scores. Statistically, it has been found that the 3rd element score is usually at the bottom of the ranking. According to the countries, it was understood that the 3rd element score was the highest among the Tokyo 2020 team element scores, and the 2nd element score was mostly in the last place. Statistically, it has been seen that the scores of these two elements differ significantly from the others in the ranking, that is, the 3rd element is generally in the 1st place and the 2nd element is in the last place.

Countries in the European continent scored higher than others. More European countries participated in the Tokyo 2020 Olympic Games. It has been understood that African and Oceanian countries can only take place in the top 21 in the duet and in the top 9 in the team thanks to the Olympic quota. It has been understood that the Tokyo 2020 artistic swimming element scores are higher than the average scores of the last three world championships. Statistically, it has been understood that there is a significant difference in the element scores

of the duet between Tokyo 2020 and the average of the last three world championships. It was observed that there was a similarity in the element scores in the team. In order to get high scores, it is recommended to apply the training that will ensure the individual technical development of all athletes in duet and team element studies. In future studies, it is recommended to make a video analysis of the competition performances of the athletes for the detailed analysis of the element point deductions.

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