THE PREDICTION OF ALL-AROUND EVENT FINAL SCORE BASED ON D AND E SCORE FACTORS IN WOMEN'S ARTISTIC GYMNASTICS

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Abstract

In the present study, we try to establish whether specific disciplines in women's artistic gymnastics are equal and should the applicable Code of Points (COP) be revised in terms of point standardization on apparatus. Our sample included all-around senior female gymnasts who participated in the qualification (C-I) competitions from 2009 to 2019. The aim of our research was to determine the impact of individual apparatus D and E score in women's artistic gymnastic in relation to the final result of all-around event. The age among seniors rise from 2009 to 2019 for 1.88 years. In our analysis, we have found that the results achieved on each apparatus were significantly different. The average final scores on vault were significantly higher than on all other apparatus. Significant predictors of all-around success seem to be uneven bars D and E scores and balance beam E score. It was interesting to observe that the vault, balance beam and floor D scores were not significant predictors. Coaches can use the results from this research in their planning of preparation tactics for gymnasts in all-around, team and apparatus competitions.

Keywords: *women's artistic gymnastics, judging, competitive performance, prediction.*

INTRODUCTION

In the program of the first Olympic Games (OG), artistic gymnastics was presented for the first time in Greece (Athens) in 1896, and in 1903 at the World Championship (WCh) in Belgium (Antwerp), while at the European Championship (ECh) it was presented for the first time in 1955, in Germany (Frankfurt). Women's artistic gymnastics (WAG) first appeared at the OG in the Netherlands (Amsterdam) in 1928; at the WCh in Hungary (Budapest) in 1934, and at the ECh in Greece (Athens) in 1957, (Grossfeld, 2014). Before 1996, competitions in gymnastics were different from what we have now. On the first day of a competition, gymnasts performed compulsory exercises in qualifications as prescribed by the Fédération Internationale de Gymnastique (FIG). On the second day, they performed free exercises. For the final result, points from both performances by each gymnast were taken into consideration. In 1996, compulsory exercises were eliminated as they were considered not interesting for television or general public viewing; the scoring became simplified, it was easier to follow the competition results, which made competitions more attractive to the general

public. Shortened competitions thus became less taxing on the gymnasts (Grossfeld, 2014).

Today, assessment in artistic gymnastics is based on the international *Code of Points* (COP), which are updated and published after every Olympic Games. The female competition COP is divided into D and E parts. There are independent members of D and E judging panels on all apparatus: panel D evaluates difficulty value, special requirements and bonus points and their evaluation starts from 0.00 points; panel E evaluates the performance of an exercise (technique of execution, body posture, and balance) and makes deductions from ten points downwards. The judging panel D determines the initial value of an exercise, and panel E registers performance errors related to technical performance, body posture and balance; the two grades are added up to make the final score (FS).

The basis of all competitions in WAG is all-around event which consist of competition on four apparatus. The term "*all-around*" simply means using different gymnastics apparatus. Artistic gymnastics is a typical multidisciplinary sport with four disciplines in women's competition: Vault (VT), Uneven Bars (UB), Balance Beam (BB) and Floor Exercise (FX). Women perform maximum 8 highest difficulty value elements (DV) including a dismount that are counted on UB, BB and FX. Currently, in the Olympics or WCh competitions, the event is divided into several sessions that are held on different days: qualification (C-I), all-around finals (C-II), team finals (C-III) and event finals (C-IV). The COP for the evaluation of artistic gymnastics includes seven levels of degree of difficulty. The lowest degree represents level A=0.10 points and the highest difficulty level is I=0.90 points (FIG, 2017). Two of the primary purposes of the WAG COP (FIG, 2017) is to "*provide an objective means of evaluating gymnastics exercises at all levels of regional, national and international competitions" and "assure the identification of the best gymnast in any competition"* (FIG, 2017).

In artistic gymnastics, the emphasis is on the aesthetic component, which must be performed in accordance with the prescribed movement structure. Although the methods of evaluation in individual sports differ, there are always criteria that determine how the final result is calculated. For individual sports, such as: figure skating, diving, synchronized swimming, gymnastics, including *acrobatics, aerobics, rhythmics, trampoline, artistic gymnastics;* ski jumping, freestyle snowboard: *snowboard-halfpipe and slopestyle*; dance, aerials, etc., it is typical that judges evaluate the quality of competitive effects on the basis of displayed compositions or jumps (Atiković, 2012).

The specificity of the gymnastics competition is that the result is not expressed in physical units (meter, kilogram or second); nevertheless, the technique of performing exercises is evaluated strictly and subjectively on the basis of pre-determined difficulty values of individual elements and compositions as a whole as prescribed by the relevant COP. Artistic gymnastics is a sport with a primary requirement of mastering techniques to perform most varied specific exercises. This means that learning new, more complex and demanding elements is the everyday principle of the training process (Ferkolj, 2010).

Whether technique is properly executed is largely decided on the efficiency of the visual performance. This means that it often happens that a harmless error in the technique of performing a complex element devalues or even prevents the entire element from being performed (Atiković and Smajlović, 2011).

Several critical aspects of performance judging were already identified in the past at various competitions and several propositions for further improvements in this field have

been made (Ste-Marie, 2000; Atiković and Smajlović, 2011; Plessner and Schallies, 2005; Boen, van Hoye, Vanden, Feys and Smits, 2008; Leskošek, Čuk, Karácsony, Pajek and Bučar 2010; Bučar, Forbes, Pajek, Leskošek and Čuk 2011; Bučar, Čuk, Pajek, Karácsony and Leskošek, 2012; Pajek, Čuk, Pajek, Kovač and Leskošek, 2013; Heiniger and Mercier, 2018; Atiković, Kamenjašević, Nožinović, Užičanin, Tabaković and Ćurić, 2020). The system works well for apparatus specialists; the more you show, the higher the score. However, for gymnasts in all-around individual (AAI) competitions there can be a problem due to the apparent equivalence among apparatus, even though there are special rules that apply only to vault. Gymnasts in AAI competitions only perform one jump on vault, while on the other three apparatus they present a series of elements that make their routines (Čuk and Forbes, 2010). The aim of our research was to determine the impact of D and E score on individual apparatus in relation to the final result in the all-around event in WAG.

METHODS

The number of competitors in the qualification round (C-I) varies from year to year. Our sample included all-around senior female gymnasts who participated in the qualification (C-I) competitions at WCh and/or OG held in: 2009 London (GBR), n = 79; 2010 Rotterdam (NED), n = 140; 2011 Tokyo (JPN), n = 154; 2012 London (GBR), n = 59; 2013 Antwerp (BEL), n = 80; 2014 Nanning (CHN), n = 154; 2015 Glasgow (GBR), n = 190; 2016 Rio de Janeiro (BRA), n = 59; 2017 Montreal (CAN), n = 74; 2018 Doha (QAT), n = 143 and 2019 Stuttgart (GER), n = 173.

We analysed the chronological age trend from the Longines official book results of the FIG of all-around female participants in WAG for the period of 2009 to 2019 (*see* Appendix). We used E score (or Execution score), D score (or Difficulty score) and FS from four apparatus: VT, UB, BB and FX as variables.

The data were analysed using the Statistical Package for Social Sciences – version 23.0 (SPSS Chicago, USA) and Microsoft Office Excel 2013. Descriptive statistics were calculated using the mean (M) values as a measure of central tendency, standard deviation (SD) as a measure of dispersion. Five percent level of significance $p < 0.05$ was considered for all statistic parameters except Pearson correlation was $p < 0.01$. We used regression analysis (method enter) as a form of predictive variables (predictors). For calculating the chronological age, the formulas from the Microsoft Office Excel 2013 package were used for the total *number of days* of one's age since the date of birth until the first day of the competition qualifications.

RESULTS

Despite all the results in Table 1, the results of VT in all competitions show significantly higher values in FS in comparison to other apparatus in all competitions. Value ratings range from VT FS 2018 13.080 points to VT FS 2016 14.244 points. In all competitions, this discipline has the highest average value. The lowest values are in UB FS 2009-2011, 2014-2015 and 2019, BB FS 2012-2013, 2016-2019 years. Analysing the results in arithmetical environments, the highest values were recorded for WCh 2019 (M = 20.18, SD = 3.67) years of age, and the lowest for WCh 2009 (M = 18.30, SD = 2.17) years. According to the results presented in Table 2, female participants were getting older from WCh 2009 to WCh 2019 by 1.88 years Fig 1.

We found statistical difference in age between 2009 and 2019 (t_{250} = 3.861, $p <$ .000). It is evident that the trend of decreased scores happens gradually after the end of OG because new young

gymnasts are coming to competitions. At WCh, the correlation is small (15 or 16%) and almost negligible. There is a statistically significant positive correlation in Table 2 between the years of chronological age and the results in all-around competitions in years 2014 (*r*: 0.165, p < 0.041), 2015 (*r*: 0.155, p < 0.033), and a negative correlation of 29% at Olympic Games 2012 (*r*: -0.299, *p* < 0.022). These results at the OG show that the older the gymnasts get, the lower the number of points. It is evident that the trend of lowered scores happens gradually after the end of OG. Fig 2.

Table 1
Statistics of D, E and FS scores with mean results each apparatus.

Years	Vault (VT)				Uneven Bars (UB)			Balance Beam (BB)			Floor Exercise (FX)		
	N	D	E	FS	D	E	FS	D	E	FS	D	E	FS
2009	79	4.992	8.340	13.286	4.937	7.014	11.949	5.002	7.273	12.279	4.988	7.413	12.343
2010	140	4.935	8.580	13.505	4.861	7.069	11.930	5.076	7.368	12.441	4.891	7.961	12.808
2011	154	5.014	8.427	13.434	5.023	6.846	11.868	5.162	7.369	12.527	5.035	7.536	12.495
2012	59	5.394	8.617	13.994	5.611	7.810	13.388	5.545	7.503	13.041	5.355	8.046	13.332
2013	80	5.047	8.691	13.706	5.035	7.285	12.320	5.246	6.992	12.224	5.197	7.277	12.413
2014	154	4.979	8.798	13.755	4.829	7.165	11.995	5.099	7.277	12.365	5.079	7.412	12.430
2015	190	4.985	8.753	13.724	4.813	6.849	11.641	5.031	7.003	12.014	5.035	7.603	12.595
2016	59	5.428	8.835	14.244	5.700	8.086	13.786	5.608	7.738	13.338	5.462	7.970	13.395
2017	74	4.572	8.696	13.246	4.733	7.363	12.088	4.902	6.205	11.084	4.729	7.337	11.987
2018	143	4.531	8.569	13.080	4.490	7.113	11.602	4.803	6.597	11.392	4.617	7.486	12.050
2019	173	4.657	8.759	13.387	4.558	7.266	11.799	4.822	6.457	11.218	4.646	7.429	12.019

Abreviation: N; N is used to indicate the total number of subjects sampled, D; difficulty score, E; Execution score and FS; final score.

Table 2
Pearson correlation coefficients between average age and women's all-around qualifications (C-I) final score.

Years	N	M_AGE	SD	M_AAI_FS	SD	r	p
2009	79	18.30	2.171	49.858	4.708	-.136	.231
2010	140	18.33	2.377	50.686	4.025	.152	.073
2011	154	18.98	2.646	50.324	4.318	.006	.939
2012	59	19.92	3.228	53.756	3.587	-.299	.022*
2013	80	19.04	2.738	50.664	4.266	-.042	.710
2014	154	19.43	3.118	50.546	3.842	.165	.041*
2015	190	19.67	3.291	49.976	4.683	.155	.033*
2016	59	20.35	3.351	54.764	3.088	.018	.892
2017	74	19.40	3.056	48.406	4.398	.005	.964
2018	143	19.78	3.595	48.125	3.956	.088	.293
2019	173	20.18	3.674	48.470	4.111	.070	.359

*Abreviation: N; N is used to indicate the total number of subjects sampled, M; Mean – This is the mean of the variable, SD; This is the standard deviation of the variable, AGE; Chronological Age, AAI_FS; All-Around Final Score, r; The correlation coefficient can range from -1 to +1, p; p-value associated with the correlation is significant at the *p < .05 level (5% significance).*

Table 3
Pearson correlation matrix.

AAI_FS	N	VTD	VTE	UBD	UBE	BBD	BBE	FXD	FXE
2009	79	.747	.644	.820	.811	.702	.784	.825	.851
2010	140	.762	.571	.786	.747	.778	.764	.786	.706
2011	154	.690	.575	.784	.801	.803	.734	.786	.747
2012	59	.818	.605	.709	.715	.760	.688	.781	.636
2013	80	.626	.629	.774	.746	.813	.780	.783	.731
2014	154	.666	.586	.774	.719	.757	.716	.799	.660
2015	190	.662	.581	.821	.731	.814	.746	.871	.736
2016	59	.485	.532	.709	.691	.726	.735	.768	.650
2017	74	.735	.617	.743	.745	.701	.790	.772	.692
2018	143	.725	.521	.787	.660	.708	.735	.821	.650
2019	173	.695	.551	.806	.754	.699	.703	.783	.666

Abreviation: AAI_FS; All-around final score, All correlations are significant p < 0.01.

Table 4
Regression analysis (method Enter), predicted AAIFS variable (Beta Coefficients).

Years	VTD	VTE	UBD	UBE	BBD	BBE	FXD	FXE
2009	.109	.098	.202	.259	.133	.209	.106	.156
2010	.125	.078	.214	.285	.150	.242	.112	.125
2011	.117	.060	.221	.289	.139	.209	.120	.161
2012	.151	.120	.195	.244	.175	.277	.091	.141
2013	.132	.116	.207	.231	.141	.225	.121	.173
2014	.134	.079	.238	.269	.147	.212	.121	.189
2015	.114	.068	.244	.229	.113	.218	.177	.143
2016	.162	.155	.198	.228	.176	.221	.187	.162
2017	.128	.095	.192	.266	.120	.249	.104	.209
2018	.145	.099	.267	.210	.135	.275	.116	.155
2019	.135	.113	.285	.222	.110	.239	.136	.136

Abreviation: All correlations are significant p < 0.01; F-test of significance for all is p < 0.000.

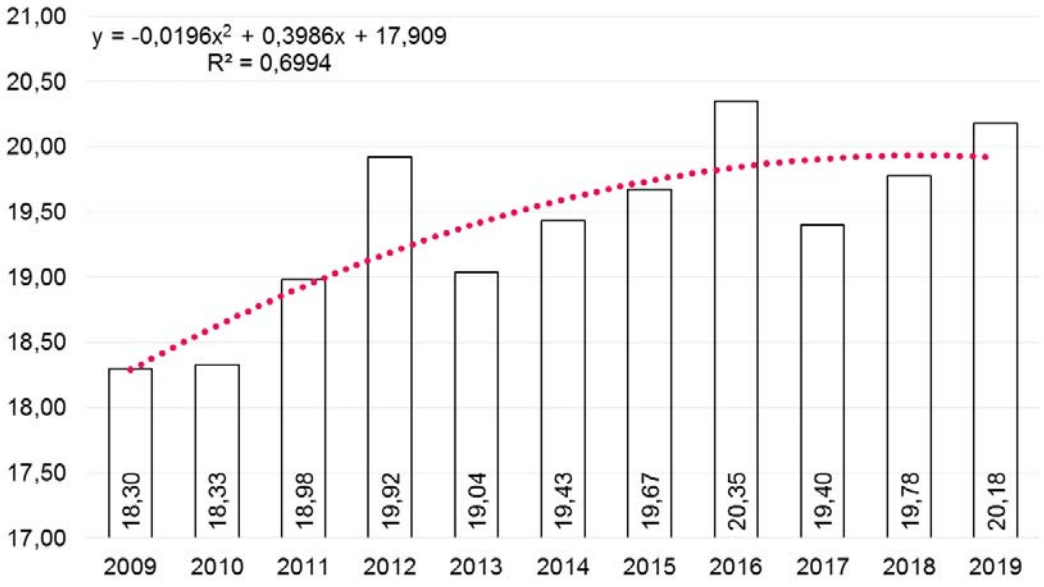

Figure 1. Average age women's all-around qualifications (C-I), second-order polynomial-regression equations, 2009–2019.

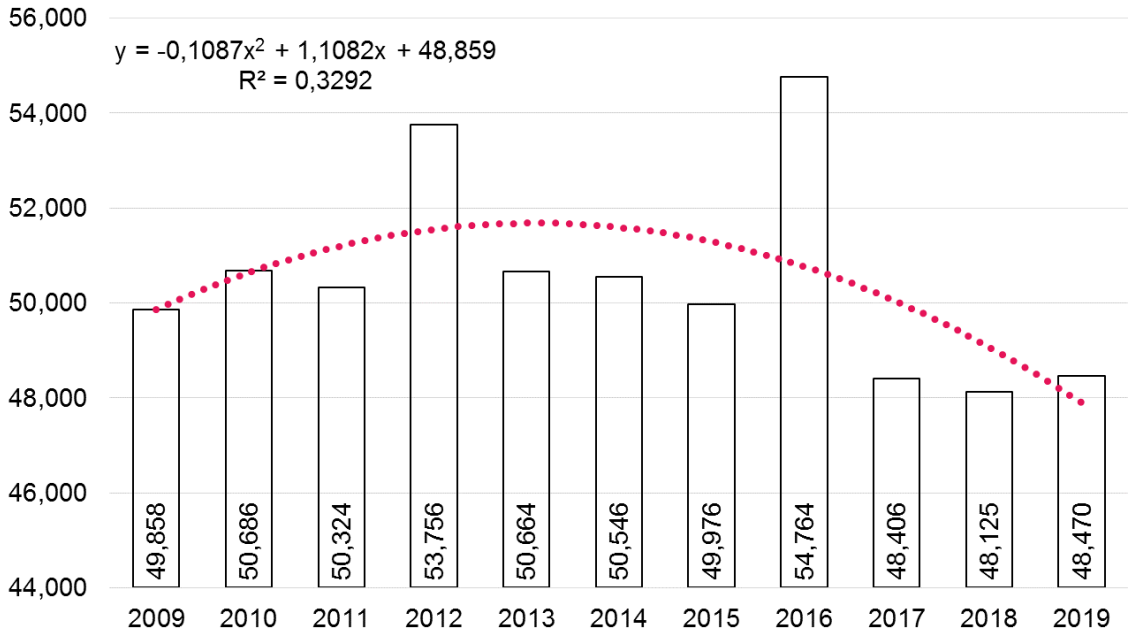

Figure 2. Results for women's all-around qualifications (C-I), second-order polynomial-regression equations, 2009–2019.

In the intercorrelation matrix in Table 3, the criterion variable AAI FS presented as the sum of all variables made statistically significant relationships with several variables: FX D from 2009 to 2021, BBD from 2010 to 2016, UB D from 2009 to 2010, UB D from 2014 by 2015 and UB D from 2018 to 2019. What we are noticing is that these are estimates that define the weight value of a composition on these apparatus.

All the regressions in Table 4 had such a prediction, which was not our aim. Should we analyse separately D and E results, the prediction would be much smaller (Čuk and Forbes, 2010). In gymnastics, we have no way of separating one D or E score from another because each score has its value. With the linear regression analysis between AAI FS and D and E scores for each apparatus (method enter) we have predictors of AAI success. Significant predictors of AAI success are UB D and E scores and BB E scores. It was interesting to observe that VT, BB and FX D scores were not significant predictors of AAI. It seems that it is more important to perform a slightly less difficult exercise well than a more difficult exercise with a fall.

DISCUSSION

If we compare the age of gymnasts in women's artistic gymnastic by years we can conclude that there is an increased complexity in the COP in terms of DV and an increased number of deductions which coincide with the need for a longer competitive career (Atiković, Delaš and Čuk, 2013[a]; Atiković, Delaš and Čuk, 2013[b]). This means that learning new, more complex and more demanding elements is the working principle of the training process. As such, it increases the length of training (Atiković, et al,, 2013[a]). For example, a gymnast like Simone Biles (USA) continues to develop and challenge the norms of WAG with her creative and technical abilities and skills. Biles at WCh 2019 in Stuttgart successfully performed a new element, a triple double, on FX, which was given a J value. It's worth one point. Previously, the highest element value was I (9/10th of a point). Many athletes achieved their best results in the final years before

the end of their sports career. Nowadays, professional athletes are expected to quit sport at a certain age, but sometimes such perceptions can be misleading. Namely, the average gymnast's age has changed in the last 15 years (Atiković et al., 2013[a]). Male gymnasts between 2003 and 2016 grew 2.3 years older and female gymnasts 3.3 years older. Atiković (2020) showed that top female gymnasts' chronological age increased by 4.02 years OG1996, (n = 105, M = 16.77, SD = 2.02); OG2000, (n = 97, M = 17.65, SD = 2.10); OG2004, (n = 98, M = 18.73, SD = 2.85); OG2008 (n = 97, M = 19.01, SD = 3.03); OG2012, (n = 96, M = 20.43, SD = 3.65); OG2016, (n = 98, M = 20.79, SD = 4.36).

In the near future, we expect (with further apparatus specialization in WAG) that age will increase further. Some gymnasts, such as Oksana Chusovitina (UZB), are successful at the age of 44 and ranked high in major competitions. Oksana Chusovitina will compete at her eighth Olympics in 2021, setting another age record at 46.14 years.

Unlike on other apparatus, in the all-around event a completely different philosophy of grading is applied to VT. On VT, gymnasts are allowed to perform only one element or one jump in contrast to other apparatus where the number of elements performed is significantly higher. On other apparatus gymnasts are expected to have 8 elements from different groups in their composition (FIG, 2017). The VT itself has to be pre-announced to the judging panel so that the panel and the audience know in advance what the gymnast will do in each of the vaulting phases. One harmless error during one of the vaulting phases can make the gymnast abort the announced jump and not be assessed. Unlike on VT, on other apparatus of gymnastics all-around event, the competitor can make a mistake in one of the elements and still get points for the whole composition. The difficulty value and bonus points are predetermined for each jump and presented in the form of rotation around the vertical and frontal axis. On other apparatus, gymnasts have the opportunity to achieve bonus points for connections between elements.

After our analysis of competitions, it is clear that some groups and types of jumps are more represented than others. The most represented are from Group 4, followed by Group 2 and Group 3. Most gymnasts had a start value of 4.60 p. The most frequent vault during the qualifying period is jump number 4.32, or as its description states: "*Round-off, flic-flac on – stretched salto bwd with 1/1 turn (360 °) off*" with 4.60 p. It can be noticed that very few jumps from other groups are performed. Jumps from *Group 1* type handspring, Yamashita, round-off with or without turn in 1st and/or 2nd flight phase, and jumps from *Group 5* type round-off with 1/2 turn (180°) in 1st flight phase – flip fwd/bwd with/without turn in 2nd flight phase are rarely performed at competitions.

During training, the time spent on VT is not the same as the time spent on other apparatus in men's artistic gymnastics (Hadjijev, 1989). In the past, normally the least amount of training time was dedicated to VT, and the most amount of time was spent on pommel horse (PH). Training times on on each of the other apparatus were similar (the gymnast's preferences, abilities, and individual characteristics are also important in determining training time spent on each apparatus (Hadjijev, 1989).

Interesting research on the use of information communication technology for sporting purposes and their implementation in practice was presented in 2011. Its authors (Bučar Pajek et al., 2011) created a program at the Australian Institute for Sport that worked as a "*real time judging system*". The program improved the objectivity of evaluation by the judging panel E as deductions were entered during gymnast's performance and could not be modified; judges had to deduct quickly and the moment they obseved a mistake. Similar research, conducted by Sands,

2010, under title "J*udging in Real Time*", mentioned the biggest problem of evaluation, and that is reliability and validity. In his paper, the author noted that judges could use modern technology and with that make their deductions immediately after a gymnast's performance.

Assessing the results of men's all-around qualifications at OG 2008, Čuk and Atiković (2009) found that VT was considered the most valuable apparatus, and the PH was less valued among all-around gymnasts. Using the COP, it is very hard to obtain a high D score on PH and easier to obtain a high D score on VT. Pairwise *t*-tests showed that D scores between VT and other apparatus, and between PH and other apparatus were significantly different. Equality of disciplines has been tested by other authors. On a sample of 49 all-around male gymnasts at the ECh 2009, the implications of the difficulty of scores were tested in relation to the success in all-around competition. Only one group had a chance to win an all-around medal; difficulty scores between all six apparatus were not equal; the highest prediction of the all-around score was the parallel bars difficulty score (Čuk and Forbes, 2010). One of the attempts to identify the most important routine apparatus for success in WAG at WCh was conducted in 2011 (Massidda and Calò, 2012). Performance scores on UB and BB for women, and on PH for men were least influenced by competitor's standing. Scores on UB, BB, and PH were consistently good predictors of final standing. The results suggest that high scores on these apparatus have a greater influence on overall performance than scores on the other apparatus, regardless of competitors' level.

It is possible to conclude that judging in artistic gymnastics is extremely complex. Studies that address it are mostly focused on metric characteristics of judging. In one (Bučar et al., 2012; Pajek et al., 2013), the authors investigated the reliability and validity of judging at the ECh in Berlin 2011. Thy concluded that the quality of judging was comparable to other examined gymnastics competitions at different levels and emphasized that inferior results on VT and FX require further analysis. Another study (Čuk, 2015) dealt with the predictors of success when spectators served as judges. It showed that the reliability of their judging was the same as when performed by official judges. Their rankings closely corresponded to the rankings set by official judges. With modern technology, such as smart mobile phones, FIG could organise some experimental judging by fans. Fujitsu Ltd has developed a judging system that can objectively score a routine based on the angles of gymnasts' joints. The system works by capturing the gymnasts' movements with a 3D laser sensor and analysing them as numerical data. After 2020, the program is expected to calculate the difficulty value and the execution score. This kind of technology will enable more objective judging in artistic gymnastic. Additional sports presentation information will also be made available for enhanced viewing by spectators in the arena as well as on television or social media (Fujiwara and Ito, 2018).

Technology has improved the accuracy, enjoyment, and experiences of both athletes and spectators at sporting events. Some of the key technological advancements for athletes and spectators include improved time-tracking systems, clothing, equipment, goal-line technology, video technology, GPS data tracking, virtual imaging, accuracy and decision systems (hawk-eye), coverage of events around the world via the internet and on multiple devices. In *athletics*: tracking race times and clothing; *football*: goal-line technology (GLT) and video technology (also known as VAR); *rugby*: data tracking (GPS tracking to collect data and stats on player performance) and video technology (hawk-eye video review technology is used

by television match officials (TMO) for better decision-making); *swimming*: virtual imaging, divecam and swimsuits, *tennis*: hawk-eye line-calling system, radar guns and tennis racquets; *gymnastics*: Instant Replay and Control System (IRCOS) and smart rings, etc. (Čuk and Atiković, 2009; Bučar Pajek et al., 2011; Aarts and Pluk, 2014, Čuk, 2015). IRCOS is a program that gives judges the ability to immediately visually review gymnasts' routines. Judges can analyse recorded video in the case of a scoring dispute among judges or a protest filed on behalf of a gymnast. In competitive men's artistic gymnastics, an exercise on still rings is composed of swing, strength and hold positions. All strength and hold positions must be held for a minimum of 2 seconds, otherwise a deduction of 0.3 points for each incomplete hold position is applied to the execution score by the execution jury (E-judging panel). An innovative measurement system called "*smart rings*" is based on the forces that a gymnast exerts on both rings and helps judges evaluate elements on this apparaus (Aarts and Pluk, 2014). Both systems provide important tools for the more accurate review of gymnasts' exercises. It is certain that FIG will have to facilitate more accurate evaluations in the future, either by using new modern technologies, or a better evaluation system, or both.

In the past, many different ways of calculating the FS were used in gymnastics. Author's Čuk, Fink and Leskošek (2012) compared 14 different models for calculating the final scores. Due to the lower complexity of VT routines (in comparison with other apparatus), those who perform well on VT can get a higher FS. An analysis of training loads shows that VT is also an apparatus where the least training time is spent (Atiković and Smajlović, 2011).

Author Fujihara contributed a significant review of previous research (Fujihara, 2016). One of the objective ways to determine the start value of vault is to use biomechanics characteristics of vault (Ferkolj, 2010; Atiković and Smajlović, 2011; Atiković, 2012; Farana and Vaverka, 2012; Farana, Uchytil, Zahradník and Jandačka, 2015; Fujihara, Yamamoto and Fuchimoto, 2017). Atiković and Smajlović (2011) tried to define which biomechanical parameters explain and define the DV. Their study showed that it explained 92.4% of the vault DV. For example, authors were able to prove that only 3 biomechanical variables were predictors: *degrees of turns around the transversal axis, degrees of turns around the longitudinal axis and body's moment of inertia around the transversal axis in the second flight phase*. With this research, its authors have confirmed that initial points on VT or other apparatus can be more objectively determined by the expert commission of the male and female technical committee of FIG. Unfortunately, the points for WAG so far have been dictated by experience rather than by scientific work and research.

Between two Olympic cycles, WAG COP 2013-2016 and 2017-2020 saw minor changes in Composition Requirements (CR) on apparatus - instead of 5 CR it is now 4 – as a few dismounts from UB, BB, and FX were dropped, due to the risk of injury when performing dismounts with high difficulty requirements (D, E and more). The new COP WAG 2017-2020 has a lower CR value, (2.00 points down from 2.5 points) but D evaluation is the same as it was in the last COP. Today's philosophy when developing gymnastics composition on an apparatus is based on safe performance, the fulfillment of all CR, and safe landing. Uncertainty or a fall may lead to a loss of placement in a competition and, thus, a change in the expected final score (FS). The change in the formation of D score did not lead to a change in the FS, because the DV has evolved and increased from 2009 (G=0.70 p.), 2013 (H=0,80 p.) to 2017 (I=0.90 p.). All gymnasts tend to perform their gymnastics composition with a maximum D score, but D score can be

differentiated differently. VT as a way to a higher FS in all-around is correct but no less demanding.

The results in WAG, especially on VT, should be equalised for all disciplines which is not the case at the moment. The results of this conducted research could be used as the basis for the launch of a change in the COP 2021-2024.

CONCLUSION

In the analysed results presented in this article, VT features significantly higher than other disciplines that make the all-around competition. The differences can be up to two points between two apparatus, e.g., VT and BB. This system works best for discipline specialists. However, in all-around the problem still exists and arises from the inequality between disciplines, that is, VT has special rules compared to UB, BB, and FX. A gymnast on VT shows one vault in all-around. In comparison to other disciplines, vault is similar to one element in a BB exercise. Significant predictors of AAI success are UB D and UB E scores and the BB E score. It was interesting to observe that VT, BB and FX D scores were not significant predictors of AAI. Coaches can use the results from this research for the planning of preparation tactics for gymnasts in all-around, team and apparatus competitions.

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APPENDIX

2019 https://www.gymnastics.sport/site/events/searchresults.php#filter
2018 https://www.gymnastics.sport/asset.php?id=fidb_7803
2017 https://www.gymnastics.sport/asset.php?id=fidb_7802
2016 https://gymnasticsresults.com/results/2016/olympics/index.html
2015 https://www.gymnastics.sport/asset.php?id=fidb_7801
2014 https://www.gymnastics.sport/asset.php?id=fidb_7798
2013 https://www.gymnastics.sport/asset.php?id=fidb_7797
2012 https://gymnasticsresults.com/results/2012/olympics/index.html
2011 https://www.gymnastics.sport/asset.php?id=fidb_7796
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