Original Article

Analysis of the differences in the results of the year 2019 between the world best juniors and seniors in men's artistic gymnasts

ALMIR ATIKOVIĆ¹, AMRA NOŽINOVIĆ MUJANOVIĆ², EMILIJA PETKOVIĆ³, SUNČICA DELAŠ KALINSKI⁴, JURAJ KREMNIČKY⁵

^{1,2} Faculty of Physical Education and Sport, University of Tuzla, BOSNIA and HERZEGOVINA

³ Faculty of Sport and Physical Education, University of Niš, SERBIA

⁴ Faculty of Kinesiology, University of Split, CROATIA

⁵ University of Matj Bel, The Faculty of Humanities, The Department of Physical Education and Sports, Banská Bystrica, SLOVAKIA

Published online: May 30, 2020

(Accepted for publication: May 18, 2020)

DOI:10.7752/jpes.2020.03176

Abstract

The subject sample was composed of N=293 gymnasts who competed at the 49th FIG Men's Senior Artistic Gymnastics World Championships (Stuttgart, GER) and N=134 gymnasts who competed at the 1st FIG Men's Junior Artistic Gymnastics World Championships (Gyor, HUN). This study aimed to determine the differences between the two age groups of gymnasts (juniors and seniors) in all the predictor variables by analyzing the D-difficulty score, E-execution score and FS-final score from 6 apparatus: Floor Exercise (FX), Pommel Horse (PH), Rings (RI), Vault (VT), Parallel Bars (PB), High Bar (HB). The E jury score is no different during the competition. Average D and FS scores on the vault are significantly higher than on all other apparatus. The study established significant differences between the samples in almost all the analyzed scores. The results of the independent t-test were significant, indicating there a significant difference between juniors and seniors is 7.4 years of age. We can conclude that juniors and seniors differ significantly in D scores, and the FS final scores without making a big difference in the performance technique of the composition in the E scores: Q = qualification (C-I), AAF = all-around finals (C-II), TF = team finals (C-III) and AF = apparatus finals. Based on what was presented in the work, the importance of the permanent identification of how to reach the maximum potential of how to determine team competition strategy, should we strive for the balanced development of all disciplines, do you intensify one or a combination of discipline groups, which disciplines have the most positive transfer to other disciplines, what disciplines are most contributing to success?

Keywords: Artistic Gymnastics; World Championships; Elite Athletes; Differences, Comparison.

Introduction

Artistic gymnastics is a sport with six disciplines in men's competitions: Floor Exercise (FX), Pommel Horse (PH), Rings (RI), Vault (VT), Parallel Bars (PB), High Bar (HB) and men's perform at the competition the maximum 9 biggest difficulty value (DV) including the dismount. In the Olympic Games (OG) or World Gymnastics Championships (WCh), the meet is divided into several sessions that are held on different days: Q = qualification (C-I), AAF = all-around finals (C-II), TF = team finals (C-III) and AF = apparatus finals (C-IV).

In the program of the first Olympic Games (OG), artistic gymnastics were presented for the first time in 1896 in Greece (Athens), and in 1903 at the World Championship (WCh) in Belgium (Antwerp), while at the European Championship (ECh) for the first time it was presented in 1955, in Germany (Frankfurt). Women's artistic gymnastics (WAG) first appeared at the OG in 1928 in the Netherlands (Amsterdam), and at the WCh appears in 1934 in Hungary (Budapest), at the ECh in 1957 in Greece (Athens) (FIG, 2017).

Since 1996, competition in gymnastics were different than it is today. On the first day of competition, in qualifications, gymnasts were show compulsory exercises, stipulated from the Fédération Internationale de Gymnastique (FIG). While on the next day, they performed free exercises. For the final result, points for both performances of gymnasts were taken into consideration. Reasons given for eliminating the compulsory exercises: they were not interesting for television or public viewing; the scoring, especially with "new life", simplified following the competition results, making it more attractive to the public. Also, the competition was done, which was less taxing for the gymnasts (FIG, 2017). The first official Code of Points (COP) FIG was issued in 1948, printed on 12 pages. Before 1948, only general data from the technical ordinance was used. In 1964, a lot of experience gained in previous years lead to the creation of a new COP, which contained elements (A, B, and C), combinations, and other general provisions.

Today, for the assessment of artistic gymnastics, the international competitive COP for the assessment of men's and women's artistic gymnastics is in effect, which is being improved and published after the OG finish (Atiković, 2012). The biggest changes happened in 2006 when the assessment of composition ceased to be limited with ten points, as the highest possible point. From that year 2006, the point is divided into D and E parts. Independent members of the D & E jury are on all apparatus: D jury evaluates (difficulty value, special requirements and bonus points) and the D jury starts from 0.00 points to more and E jury the performance of an exercise (the technique of execution, body posture, and balance), and provides deductions for the performance from ten points to lower. D jury determines the initial value of an exercise, and the E jury registers performance errors due to technical performance, body posture, and balance of exercise performance so that those two grades would at the end sum up in the final score. In artistic gymnastics, the emphasis is on the aesthetic component, which must be performed by the conventionally defined movement structure. Although the methods of evaluation in individual sports differ among themselves: either by the number of judges, the criteria set or how the final result is calculated, for individual sports such as: (figure skating, diving, synchronized swimming, gymnastics: acrobatics, aerobics, rhythmic, trampoline, artistic, dressage: gp & gp special and gp freestyle, ski jumping, freestyle snowboard: snowboard-halfpipe and slopestyle, dance, aerials, etc.) it is characteristic that judges evaluate the quality of competitive effects based on the displayed compositions or jumps (Atiković, 2012). Artistic gymnastics is a sport with a primary requirement of adopting the technique of the most varied specific exercises. This means that learning new, more complex, and demanding elements is the everyday principle of the training process (Ferkolj, 2010). The properly mastered technique is largely decided on visual performance efficiency. This means that it often happens that a harmless error in the technique of performing a complex element disparage or even prevents the entire element from being performed (Atiković & Smajlović, 2011). Several aspects of judging performance were already described in the past at various competitions and several propositions for further improvements in this field were made (Atiković & Smajlović, 2011; Popović, 2000; Ste-Marie, 2000; Ste-Marie, Valiquette, & Taylor, 2001; Plessner & Schallies, 2005; Boen, van Hoya, Vanden Auweele, Feys, & Smith, 2008; Leskošek, Čuk, Karácsony, Pajek, & Bučar, 2010; Dallas & Kirialanis, 2010; Bučar Pajek, Forbes, Pajek, Leskošek, & Čuk, 2011; Bučar, Čuk, Pajek, & Leskošek, 2012; Pajek, Čuk, Pajek, Kovač, & Leskošek, 2013; Heiniger & Mercier, 2018).

For the official competitions age of gymnast for the OG the gymnast must, in the year of the competition, have the following minimum age: Seniors Men's Artistic Gymnastics 18 years Women's Artistic Gymnastics 16 years Juniors in Men's Artistic Gymnastics the gymnast must be not less than 14 years of age not more than 17 years. Women's Artistic Gymnastics the gymnast must be not less than 13 years of age not more than 15 years (FIG Technical Regulations Art. 5.2. Pg. 37, 2019). This study aimed to determine the differences between the two age groups of gymnasts (juniors and seniors) in all the predictor variables by analyzing the D, E, and FS score achieved at the 2019 World Championships in (Gyor and Stuttgart).

Materials and methods

Sample Entity

Our sample was composed of N=259 gymnasts who competed at the 49th FIG MAG Artistic Gymnastics Senior World Championships Stuttgart (GER) and N=119 gymnasts who competed at the 1st FIG MAG Artistic Gymnastics Junior World Championships Gyor (HUN). In some disciplines was the smaller number of gymnasts because there is a qualifying competition in which it competes only specialists in a particular apparatus so that the number of gymnasts on individual apparatus is considerably smaller.

Data collection

We have made analysis results from the official book results of the Fédération Internationale de Gymnastique (FIG) of male participants in MAG for 2019. All data for this study was obtained from the website: 1st FIG Artistic Gymnastics Junior World Championships Gyor (HUN) from 27 to 30 June 2019 <https://www.jwchgyor2019.hu/en/> and 49th FIG Artistic Gymnastics Senior World Championships Stuttgart (GER) from 4 to 13 October 2019 <https://www.stuttgart2019.de/en/>

Variables

We made variables of judges E, D and FS final score (D + E score) from 6 apparatus: Floor Exercise (FX), Pommel Horse (PH), Rings (RI), Vault (VT), Parallel Bars (PB), High Bar (HB).

Data processing methods

The data were analyzed 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. We used Paired Sample T-Test, to determine whether there were significant differences between the apparatus. Factor analysis was used to determine the latent structure of all variables. For calculating the chronological age we used formulas from Excel 2013 for the number of days of one's age since the date of birth until the first day of the competition qualifications:

$$\text{Formula} = (A1; B1; "d") \quad (1)$$

$$\text{Formula} = (\text{days} \times 0.0027397260273973 \text{ yrs}) \quad (2)$$

Results

In (Table 1) the central and dispersal result parameters from the MAG juniors and seniors. Analyzing the parameters of the central tendency of minimum and maximum values it can be established that the juniors are on average old ($N=134$; $M=16.72$; $SD=.531$) and seniors are on average old ($N=293$; $M=24.22$; $SD=3.80$). The results in (Table 1) of independent t-test were significant, $t\text{-test}(425) = 11.731$, $p < .000$, indicating that there a significant difference between juniors and seniors is 7.49 years of age.

Table 1. The difference between junior and senior in chronological age

Category	N	M	SD	t	df	p value	Mean Difference
Senior	293	24.22	3.800	22.731	425	.000	7.499
Junior	134	16.72	.531				

Abbreviations: N, Number of Participants, M, Mean; SD, Standard deviation; t value, df, degrees of freedom, p, $p < 0.05$.

Descriptive statistics are presented in (Table 2) In qualifications juniors ($13.121 \pm .872$) and seniors ($13.626 \pm .738$), the VT and has the highest average score. It is the same in finals with juniors VT ($13.843 .391$) and seniors PB ($14.495 \pm .627$). No, statistically significant differences between juniors and seniors in qualifications and final competition E score juniors (FX and VT) and E score seniors (FX, PH, VA, and PB).

Table 2. Men's All-Around Qualifications and Finals

All-Around		Qualifications				Finals			
		M $\pm$ SD		p	Mean Diff Points	M $\pm$ SD		p	Mean Diff Points
Score	App	Juniors N=87	Seniors N=156			Juniors N=24	Seniors N=24		
D	FX	4.457 $\pm$.469	5.220 $\pm$.589	.000	.763	4.854 $\pm$.284	5.804 $\pm$.375	.000	.950
	PH	3.906 $\pm$.752	4.761 $\pm$.876	.000	.854	4.400 $\pm$.586	5.616 $\pm$.624	.000	1.216
	RI	3.912 $\pm$.475	4.703 $\pm$.739	.000	.790	4.262 $\pm$.260	5.491 $\pm$.450	.000	1.229
	VT	4.370 $\pm$.693	4.852 $\pm$.538	.000	.482	4.866 $\pm$.304	5.300 $\pm$.243	.000	.433
	PB	4.094 $\pm$.624	5.108 $\pm$.822	.000	1.014	4.737 $\pm$.425	5.941 $\pm$.502	.000	1.204
	HB	3.824 $\pm$.626	4.860 $\pm$.770	.000	1.036	4.383 $\pm$.349	5.620 $\pm$.472	.000	1.237
E	FX	7.852 $\pm$.626	7.892 $\pm$.617	.636*	.039	8.184 $\pm$.461	8.232 $\pm$.484	.723*	.048
	PH	7.388 $\pm$ 1.107	7.091 $\pm$ 1.007	.035	.297	7.993 $\pm$.700	8.036 $\pm$.438	.800*	.043
	RI	8.233 $\pm$.632	7.892 $\pm$.485	.000	.338	8.732 $\pm$.289	8.176 $\pm$.289	.000	.556
	VT	8.796 $\pm$.387	8.823 $\pm$.445	.646*	-.026	9.018 $\pm$.414	8.957 $\pm$.479	.638*	.061
	PB	8.174 $\pm$.735	7.936 $\pm$.657	.010	.237	8.546 $\pm$.334	8.554 $\pm$.340	.935*	.008
	HB	7.918 $\pm$.675	7.721 $\pm$.676	.030	.197	8.267 $\pm$.377	7.860 $\pm$.562	.005	.406
FS	FX	12.232 $\pm$ 1.105	13.052 $\pm$.979	.000	.820	12.992 $\pm$.551	14.007 $\pm$.726	.000	1.015
	PH	11.150 $\pm$ 1.894	11.750 $\pm$ 1.963	.022	.598	12.393 .625	13.652 $\pm$.967	.000	1.259
	RI	12.019 $\pm$ 1.294	12.565 $\pm$ 1.185	.001	.549	12.994 .460	13.667 $\pm$.458	.000	.672
	VT	13.121 $\pm$.872	13.626 $\pm$.738	.000	.505	13.843 .391	14.228 $\pm$.549	.008	.384
	PB	12.264 $\pm$ 1.030	12.991 $\pm$ 1.483	.000	.726	13.283 .373	14.495 $\pm$.627	.000	1.212
	HB	11.647 $\pm$ 1.452	12.582 $\pm$ 1.119	.000	.935	12.650 .498	13.481 $\pm$.797	.000	-.831
All	FS	72.429 $\pm$ 5.637	76.569 $\pm$ 6.008	.000	4.140	78.157 1.242	83.533 $\pm$ 2.863	.000	5.375

Abbreviations: M, Mean; SD, Standard deviation; p, $p < 0.05$, * there is no statistical significance.

Descriptive statistics are presented in (Table 3) in qualifications juniors ($12.958 \pm .992$) and seniors ($13.707 \pm .749$), the VT and has the highest average score. It is the same in finals with juniors VT ($13.911 \pm .490$) and seniors PH ($14.740 \pm .786$). No, statistically significant differences between juniors and seniors in qualifications and final competition E score juniors (FX, PH, and HB) and E score seniors (FX, PH, VA, and PB).

Table 3. Men's Individual Qualifications and Finals

Men's Individual		Qualifications				Finals			
		M $\pm$ SD		p	Mean Diff Points	M $\pm$ SD		p	Mean Diff Points
Score	App	Juniors	Seniors			Juniors	Seniors		
D	FX	4.432 $\pm$.536	5.280 $\pm$.597	.000	-.848	5.175 $\pm$.190	6.262 $\pm$.130	.000	1.087
	PH	3.888 $\pm$.754	4.838 $\pm$.908	.000	-.950	4.775 $\pm$.631	6.377 $\pm$.323	.000	1.602
	RI	3.847 $\pm$.587	4.859 $\pm$.815	.000	-1.011	4.537 $\pm$.130	6.212 $\pm$.083	.000	1.675
	VT	4.302 $\pm$.780	4.927 $\pm$.544	.000	-.625	5.000 $\pm$.252	5.600 $\pm$.242	.000	.600
	PB	4.041 $\pm$.679	5.168 $\pm$.792	.000	-1.127	5.100 $\pm$.481	6.375 $\pm$.148	.000	1.275
	HB	3.740 $\pm$.686	4.927 $\pm$.791	.000	-1.186	4.525 $\pm$.310	6.137 $\pm$.168	.000	1.612

E	FX	7.809 ± .609	7.867 ± .651	.432*	-.057	8.537 ± .119	8.349 ± .524	.341*	.187
	PH	7.287 ± 1.164	7.157 ± 1.019	.294*	.129	7.703 ± 1.182	8.362 ± .645	.168*	.658
	RI	8.239 ± .591	7.929 ± .471	.000	.310	8.842 ± .223	8.427 ± .240	.003	.414
	VT	8.713 ± .448	8.823 ± .444	.032	-.109	8.923 ± .516	9.063 ± .447	.421*	.139
	PB	8.138 ± .726	7.945 ± .665	.017	.192	8.124 ± .672	8.289 ± .448	.573*	.164
	HB	7.879 ± .722	7.737 ± .702	.086*	.141	8.769 ± .163	7.912 ± .597	.002	.857
FS	FX	12.139 ± 1.202	13.071 ± 1.066	.000	-.931	13.699 ± .315	14.562 ± .637	.004	.862
	PH	11.004 ± 2.056	11.867 ± 2.108	.000	-.863	12.478 ± 1.396	14.740 ± .786	.001	2.261
	RI	11.879 ± 1.719	12.766 ± 1.228	.000	-.886	13.380 ± .177	14.640 ± .296	.000	1.260
	VT	12.958 ± .992	13.707 ± .749	.000	-.749	13.911 ± .490	14.644 ± .387	.000	.733
	PB	12.110 ± 1.473	13.069 ± 1.417	.000	-.959	13.224 ± .908	14.664 ± .446	.001	1.439
	HB	11.484 ± 1.671	12.665 ± 1.172	.000	-1.181	13.344 ± .240	14.049 ± .730	.021	.705

Abbreviations: M, Mean; SD, Standard deviation; p, p < 0.05; * there is no statistical significance, N, Number of Participants (Qual: FXJ 121, FXS 205, PHJ 120, PHS 205, RIJ 119, RIS 201, VTJ 121, VTS 205, PBJ 119, PBS 122, HBJ 120, HBS 199), Finals: FXD14, PHD15, RID14, VTD30, PBD14, HBD14, FXE14, PHE15, RIE14, VAE30, PBE14, HBE14, FXFS14, PHFS15, RIFS14, VTFS30, PBFS14, HBFS14).

Looking at the qualification results, we see that 34 junior teams and 25 senior teams have performed. For juniors the team consists of 4 registered gymnasts, 3 represent the team and the 2 best scores count. For seniors the team consists of 6 registered gymnasts, 5 represent the team and the 3 best scores count. Only the top 8 qualifying teams are eligible to compete in the finals. We are not able to compare the final results in the team standings because the number of male competitors is lower in juniors compared to seniors. Descriptive statistics are presented in (Table 4). In qualifications, juniors achieved an average score (26.423 ± 2.524) and seniors (42.642 ± 1.063), the VT, and have the highest average score. It is the same in finals with juniors VT ($27.872 \pm .402$) and seniors PB (43.016 ± 1.493). No, statistically significant differences between juniors and seniors in qualifications and final competition E score juniors (FX, PH, PB, and HB) and E score seniors (FX, PH, VT, PB, HB).

Table 4. Men's Team Qualifications and Finals

Team		Qualifications			Mean Diff Points	Finals			Mean Diff Points
		Mean ± SD				Mean ± SD			
Score	App	Juniors	Seniors	p		Juniors	Seniors	p	
D	FX	4.508 ± .447	5.579 ± .389	.000	-1.071	4.964 ± .479	5.912 ± .298	.000	1.012
	PH	4.002 ± .679	5.258 ± .643	.000	-1.256	4.488 ± .638	5.883 ± .532	.000	1.462
	RI	3.922 ± .467	5.212 ± .623	.000	-1.289	4.411 ± .560	5.745 ± .338	.000	1.470
	VT	4.408 ± .733	5.112 ± .396	.000	-.703	4.928 ± .411	5.300 ± .270	.000	.400
	PB	4.146 ± .632	5.511 ± .597	.000	-1.364	4.853 ± .674	6.095 ± .462	.000	1.362
	HB	3.842 ± .575	5.297 ± .624	.000	-1.455	4.356 ± .541	5.666 ± .541	.000	1.366
E	FX	7.897 ± .537	8.042 ± .595	.075*	-.144	8.140 ± .535	8.285 ± .389	.304*	.144
	PH	7.377 ± 1.092	7.475 ± .753	.464*	-.098	8.090 ± .610	8.009 ± .455	.574*	.089
	RI	8.310 ± .520	8.055 ± .363	.000	-.255	8.704 ± .269	8.330 ± .260	.000	.387
	VT	8.716 ± .476	8.922 ± .386	.001	-.205	8.813 ± .637	9.009 ± .406	.164*	.219
	PB	8.203 ± .703	8.148 ± .533	.537*	.054	8.437 ± .418	8.276 ± .423	.153*	.176
	HB	7.950 ± .648	7.923 ± .607	.762*	.027	8.233 ± .547	8.078 ± .469	.358*	.137
FS	FX	12.367 ± .774	13.546 ± .800	.000	-1.178	13.080 ± .755	14.154 ± .473	.000	1.139
	PH	11.338 ± 1.664	12.734 ± 1.143	.000	-1.395	12.578 ± .694	13.892 ± .776	.000	1.373
	RI	12.118 ± 1.224	13.267 ± .798	.000	-1.149	13.116 ± .615	14.095 ± .481	.000	1.102
	VT	13.063 ± .976	14.003 ± .597	.000	-.940	13.701 ± .587	14.334 ± .538	.000	.685
	PB	12.350 ± .965	13.656 ± .915	.000	-1.306	13.291 ± .714	14.356 ± .710	.000	1.170
	HB	11.793 ± .953	13.221 ± .813	.000	-1.428	12.589 ± .823	13.740 ± .753	.000	1.225
FSteam	FX	25.188 ± 1.125	41.410 ± 1.374	.000	16.222	26.615 ± .892	42.461 ± .966	.000	15.845
	PH	23.424 ± 1.864	39.042 ± 2.496	.000	15.618	25.370 ± 1.043	41.677 ± 1.578	.000	16.307
	RI	24.430 ± 2.707	40.377 ± 1.734	.000	15.946	26.327 ± .720	42.228 ± 1.142	.000	15.900
	VT	26.423 ± 2.524	42.642 ± 1.063	.000	16.218	27.872 ± .402	43.004 ± 1.215	.000	15.131
	PB	25.182 ± 1.519	41.694 ± 1.685	.000	16.511	26.789 ± .881	43.016 ± 1.493	.000	16.227
	HB	24.188 ± 1.346	40.469 ± 1.444	.000	16.281	25.611 ± .486	41.196 ± 1.360	.000	15.584
	ALL	148.838 ± 8.833	245.597 ± 7.709	.000	96.758	158.586 ± 2.126	253.584 ± 6.134	.000	94.997

Abbreviations: M, Mean; SD, Standard deviation; p, p < 0.05; * there is no statistical significance, qualifications: juniors 34 teams, seniors 25 teams and best 8 teams in finals.

The results are presented in (Table 5) Paired Samples Test of the analysis of the Women's All-Around final score Qualifications and Finals of juniors and seniors. It is evident that one apparatus has the biggest differences compared to all the others. The difference is more than *one point* (p) for the following apparatus: Qualifications (FX-PH, 1.081 p.; PH-VT, 1.970 p.; PH-PB, 1.114 p.; RI-VT, 1.101 p.; VT-HB, 1.473 p.) and Finals (FX-PH, 1.301 p.; PH-VT, 1.875 p.; PH-PB, 1.241 p.; RI-VT, 1.060 p.; VT-HB, 1.043 p.).

Table 5. Paired samples test all around qualifications and final score

Pair	App	Juniors					Seniors				
		M	SD	t	df	p	M	SD	t	df	p
Pair 1	FX & PH	1.081	1.590	6.342	86	.000	1.301	1.659	9.801	155	.000
Pair 2	FX & RI	.212	1.110	1.782	86	.078*	.486	1.106	5.491	155	.000
Pair 3	FX & VT	.888	1.003	-8.263	86	.000	.573	.806	-8.886	155	.000
Pair 4	FX & PB	.032	1.000	-.306	86	.760*	.060	1.303	.580	155	.563*
Pair 5	FX & HB	.584	1.441	3.784	86	.000	.469	1.044	5.619	155	.000
Pair 6	PH & RI	.869	1.646	-4.923	86	.000	.815	1.594	-6.387	155	.000
Pair 7	PH & VT	1.970	1.819	-10.098	86	.000	1.875	1.749	-13.392	155	.000
Pair 8	PH & PB	1.114	1.707	-6.087	86	.000	1.241	1.553	-9.983	155	.000
Pair 9	PH & HB	.496	2.026	-2.286	86	.025	.831	1.647	-6.306	155	.000
Pair 10	RI & VT	1.101	1.145	-8.962	86	.000	1.060	1.006	-13.157	155	.000
Pair 11	RI & PB	.244	1.220	-1.873	86	.065*	.426	1.027	-5.179	155	.000
Pair 12	RI & HB	.372	1.612	2.155	86	.034	.016	.994	-.208	155	.836*
Pair 13	VT & PB	.856	.898	8.885	86	.000	.634	1.224	6.472	155	.000
Pair 14	VT & HB	1.473	1.391	9.879	86	.000	1.043	.973	13.392	155	.000
Pair 15	PB & HB	.617	1.364	4.222	86	.000	.409	1.254	4.076	155	.000

Abbreviations: M, Mean; SD, Standard deviation; p, indicates a statistically significant difference at $p < 0.05$, * there is no statistical significance.

Factor analysis (Table 6 and 7) extracted only significant factor explained variance (54.896% the first factor for juniors and 63.368% for seniors).

Table 6. Communalities and Component

Apparatus	Juniors	Seniors	Juniors	Seniors
	Communalities	Extraction	Component	
FXF_2019	.675	.568	.822	.753
PHF_2019	.491	.618	.700	.786
SRF_2019	.595	.701	.772	.837
VTF_2019	.542	.584	.736	.765
PBF_2019	.626	.709	.791	.842
HBF_2019	.364	.622	.604	.789

Table 7. Total Variance Explained

Component	Juniors			Seniors		
	Initial Eigenvalues			Initial Eigenvalues		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.294	54.896	54.896	3.802	63.368	63.368
2	.800	13.334	68.230	.635	10.587	73.955
3	.657	10.946	79.176	.498	8.293	82.248
4	.486	8.106	87.282	.461	7.684	89.932
5	.396	6.593	93.875	.348	5.804	95.736
6	.367	6.125	100.000	.256	4.264	100.000

Discussion and Conclusions

The increased complexity of the COP in terms of difficulty value and an increased number of deductions, according to need a longer competitive internship to be successful. As artistic gymnastics becomes more and more complex during the Olympic cycle in terms of DV of elements, it is expected that gymnasts need more time for stability, experience and, safe when performing such complex exercises (Atiković, 2020). Changes in the General Rules and COP by FIG after 1997 years the trend is a significant change only on WCh but not on OG (Atiković, Delaš Kalinski, & Smalović, 2017). Many gymnasts made their best results just in the years before the end of sports careers. Nowadays, professional athletes are expected to leave sports after a certain age, but sometimes the reasons can be fooled. Namely, the average years of age have changed in the last 15 years. The MAG gymnasts from 2003 to 2016 are older for 2.3 years and WAG gymnasts for 3.3 years. In the forthcoming time, we do expect (with apparatus specialization) that age will rise (Atiković, Delaš Kalinski, & Čuk, 2017). Atiković (2020) in the results did show significant differences between women's artistic gymnastics in body weight and height over 20 years. In men's artistic gymnastics author didn't find the difference.

Average D score values are on the vault the highest. Series of t-tests show the D scores on the vault are significantly higher than on all other apparatus. Out of 15 t-tests AAI only 5 are not significant (3 for juniors and 2 for seniors). While D scores for vault are the highest, the pommel horse D scores are the lowest, the difference between VT and PH D score is 1.970 points juniors and 1.875 points seniors. In 2009, the authors (Čuk & Atiković, 2009) found similar results in their analysis. The difference between the VT and PH A score is 0,76818 points. The difference is more than one point (p) for the following apparatus: qualifications (FX-PH, PH-VT, PH-PB, RI-VT, VT-HB) and finals (FX-PH, PH-VT, PH-PB, RI-VT, VT-HB). Authors (Erceg, Delaš Kalinski, & Milić, 2014) in the study analysis of differences in the predictor variables between elite European junior and senior women gymnasts 2012 European Championship (Brussels). The study established significant differences between the samples in almost all the analyzed scores. Atiković et al., 2011 did a similar research World Championship in men's artistic gymnastics, held in 2009 in London and they found VT has the highest D and E scores, while PH the lowest D and E scores. T-tests present that those two apparatus significantly differ from other apparatus.

COP for the evaluation of the artistic gymnastics includes nine levels of degree of difficulty. The initial degree of severity represents the level A=0.10 points, and the next levels are B=0.20 p., C=0.30 p., D=0.40 p., E=0.50 p., F=0.60 p., G=0.70 p. and H=0.80 p. The final one is the greatest degree of severity. The primary purpose of the MAG COP (FIG, 2017) is to *"provide an objective means of evaluating gymnastics exercises at all levels FIG official competitions, assure the identification of the best gymnast in any competition"* (FIG, 2017). If we translate it into the difficulty (each element in the Code of Points has designed value, the value of 0,1 is designed for the easiest element; the vault is on average better rewarded for one C and one D element (Čuk & Atiković, 2009).

Factor analysis extracted one significant factor have quite similar explained variance (54% the first factor juniors, 63% the first factor seniors). In conclusion, we can say disciplines are equal. Factor analysis showed that there were no more factors compared to ten years ago (Čuk & Atiković, 2009) with 67% or 26% the first factor, 22% the second factor, and 19% the third factor.

Gymnasts have the highest D score values on vault. According to the complexity of the VT (comparing to other apparatus, not stating VT is simple!), those who VT well have the possibility of the higher final score of all-around (Čuk & Atiković, 2009). VT is according to the analysis of the load for training include apparatus with the smallest of time spent on apparatus (Cuk & Karacsony, 2004). On the other side, the lowest D scores were on pommel horse; pommel horse is a discipline which requires the highest amount of time spent in a training session. Interestingly both disciplines, that to maximize all-around scores it is better to work less on pommel horse and more on vault. While other disciplines are quite equal in sense of D scores and time spent during training sessions. At least what can be done in the next Code of Points is to lower D scores on vault and to raise the possibility to get a similar D score on other apparatus.

Based on what was presented in the work, the importance of the permanent identification of how to reach the maximum all-around potential, how to determine team competition strategy, should we strive for the balanced development of all disciplines, do you intensify one or a combination of discipline groups, which disciplines have the most positive transfer to other disciplines, what disciplines are most contributing to the success in all-around? We can conclude that juniors and seniors differ significantly in D scores and the FS final scores without making a big difference in the performance technique of the composition in the E scores: Q = qualification (C-I), AAF = all-around finals (C-II), TF = team finals (C-III) and AF = apparatus finals.

References

- 1st FIG Artistic Gymnastics Junior World Championships Győr (HUN) from 27 to 30 June, 2019. Available at: <https://www.jwchggyor2019.hu/en/>
- 49th FIG Artistic Gymnastics Senior World Championships Stuttgart (GER) from 4 to 13 October, 2019. Available at: <https://www.stuttgart2019.de/en/>
- Atiković A, Delaš Kalinski S, & Smajlović S. Historical analysis of the chronological age trend of the participants of men's artistic gymnastics who have won medals in the period between 1896 and 2016. *Journal of Physical Education and Sport (JPES)*, March 2017;17(1): Art 35, 233-39.
- Atiković A, Delaš Kalinski S, Bijelić S, & Avdibašić Vukadinović N. Analysis results judging World Championships in Men's Artistic Gymnastics in the London 2009 year. *SportLogia*. 2012;7(2):93-100.
- Atiković A, Delaš KS, Čuk I. Age trends in artistic gymnastic across World Championships and the Olympic Games from 2003 to 2016. *Sci Gymnastics J*. 2017;9(3):251-63.
- Atiković A, Delaš KS, Čuk I. Change the gymnastics minimum age requirements and the changes that have occurred in major competitions in women's artistic gymnastics. *Acta Kinesiol*. 2017;11(1):80-8.
- Atiković A, Smajlović N. Relation between vault difficulty values and biomechanical parameters in men's artistic gymnastics. *Sci Gymnastics J*. 2011;3(3):91-105.
- Atiković A. New Regression Models to Evaluate the Relationship between Biomechanics of Gymnastic Vault and Initial Vault Difficulty Values. *J Hum Kinet*. 2012;35:119-26.

- Atiković, A. Anthropometric Characteristics of Olympic Female and Male Artistic Gymnasts from 1996 to 2016. The International Journal of Morphology (Revista Internacional de Morfología), 2020:4, pp. in press (accepted for publication February, 13, 2020).
- Boen F, van Hoya K, Vanden Auweele Y, Feys J, Smits T. Open feedback in gymnastic judging causes conformity bias based on informational influencing. J. Sports Sci. 2008;26(6):621-8.
- Bučar M, Čuk I, Pajek J, Karácsony I, Leskošek B. Reliability and validity of judging in women's artistic gymnastics at University Games 2009. Eur J Sport Sci. 2012;12(3):207-15.
- Bučar PM, Forbes W, Pajek J, Leskošek B, Čuk I. Reliability of real time judging system. Sci Gymnastics J. 2011;3(2):47-54.
- Čuk I, & Atiković, A. Are Disciplines in All-around Men's Artistic Gymnastics Equal? Sport Scientific & Practical Aspects International Journal of Kinesiology. 2009;6(1&2):8-13.
- Čuk I, Karacsony I. Vault : Methods, Ideas, Curiosities, History. Ljubljana: ŠTD Sangvinčki. 2004.
- Čuk I, Fink H, Leskošek B. Modeling the final score in artistic gymnastics by different weights of difficulty and execution. Sci Gymnastics J. 2012;4(1):73-82.
- Dallas G, Kirialanis P. Judges' evaluation of routines in men's artistic gymnastics. Sci Gymnastics J. 2010;2(2):49-58.
- Erceg T, Delaš KS., & Milić, M. (2014). The score differences between elite european junior and senior women gymnasts. Kinesiology. 2014;46(1):88-94.
- Fédération Internationale de Gymnastique Technical Regulations 2019.
- Ferkolj MA. Kinematic analysis of the handspring double salto forward tucked on a new style of vaulting table. Sci Gymnastics J. 2010;2(1):35-48.
- FIG. Code of Points for Women's Artistic Gymnastics Competitions 2017.
- Heiniger S, Mercier H. National Bias of International Gymnastics Judges during the 2013-2016 Olympic Cycle, 2018.
- Leskošek B, Čuk I, Karácsony I, Pajek J, Bučar M. Reliability and validity of judging in men's artistic gymnastics at the 2009 University Games. Sci Gymnastics J. 2010;2(1):25-34.
- Pajek MB, Čuk I, Pajek J, Kovač M, Leskošek B. Is the quality of judging in women artistic gymnastics equivalent at major competitions of different levels? J Hum Kinet. 2013;37(5):173-81.
- Plessner H, Schallies E. Judging the cross on rings: A matter of achieving shape constancy. Appl Cognitive Psych. 2005;19(9):1145-56.
- Popović R. International bias detected in judging rhythmic gymnastics competition at Sydney-2000 Olympic Games. Facta universitatis-series : Phys Educ Sport. 2000;1:1-13.
- Ste-Marie DM, Valiquette SM, Taylor G. (Memory-influenced biases in gymnastic judging occur across different prior processing conditions. Res Quarterly Exercise Sport 2001;72(4):420-6.
- Ste-Marie DM. Expertise in women's gymnastic judging: An observational approach. Perceptual and Motor Skills. 2000;90(2):543-6.