CHANGE THE GYMNASTICS MINIMUM AGE REQUIREMENTS AND THE CHANGES THAT HAVE OCCURRED IN MAJOR COMPETITIONS IN WOMEN'S ARTISTIC GYMNASTICS

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Abstract
The Olympic Games (OG) and World Championships (WC) represent the crown of each athlete's career, so it is the same with gymnasts. The aims of this study it was investigate the historical analysis of the chronological age trend of all participants of women's artistic gymnastics who have won medals in the period between 1928 and 2016 has been made. The examinees were gymnasts who had won medals at the following competitions: OG from 1928 to 2016 (n = 655) and WC from 1934 to 2015 (n = 997). If we compare the age of the WAG by disciplines, the oldest gymnasts are on the BB with an average age on (OG 20.88 ± 4.93) and on VT (WC 19.79 ± 4.17) years old, and the youngest in the FX (OG 20.24 ± 4.14) and BB (WC 18.38 ± 3.62). The results of independent t test were significant difference between OG and WC on All-around individual (AAI), Valuting table (VT), Uneven bars (UB), Balance beam (BB), Floor (FX), and second place on AAI, BB and FX. Since artistic gymnastics becomes each Olympic cycle over more demanding in terms of complexity and difficulty value of the elements, it is expected fact that gymnasts need more time to acquire stability, experience and safety when performing such complex exercises in future.

***Key words**: t-test, Cohen's d, effect sizes r, women's artistic gymnastics*

Introduction

The Fédération Internationale de Gymnastique (FIG) is the governing body for gymnastics worldwide. It is the oldest established international sports federation (1881) and has participated in the Olympic Games (OG) since their revival in 1896. The first ever gymnastics World Championships (WC) took place in 1903. The FIG governs seven disciplines: Gymnastics for All (GfA), Men's Artistic (MAG), Women's Artistic (WAG), Rhythmic (RG), Trampoline (TRA), Aerobic (AER) and Acrobatic (ACRO) Gymnastics. The basis of all competitions in men's artistic gymnastics are all-around which include many different apparatuses routines, within a team or individually. Artistic gymnastics is a typical multidisciplinary sport with six disciplines in men's artistic gymnastics: Floor (FX), Pommel horse (PH), Rings (RI), Vault (VT), Parallel bars (PB), High bar (HB) and four disciplines in women's artistic gymnastics: Vault (VT), Uneven bars (UB), Balance beam (BB) and Floor (FX). The competition rules are defined in: Statutes of the FIG, Technical Regulations FIG, Code of Points, Apparatus norms which are changed and perfected by the FIG's commissions for each Olympic cycle. Chronological age refers to the number of years and days elapsed since birth. Success in gymnastics is the result of many years of extensive planning and preparation by coaches, clubs, parents and other supporting partners. Available data for this reasrch focus on ages history top levele male gymnast. The Fédération Internationale de Gymnastique, in 1980, right before the Olympic Games, decided to raise the minimum age from 14 to 15 years for international-level female gymnasts (Goehler, 1980). This rule change was followed later, in 1997, by another modification that increased the international competitive age to 16 years (Normile, 1996; Vieru, 1997). The results of the female data are presented authors (Claessens et al., 1991): OG1964 Tokyo; *n* =102, *M* = 22.7, (Hirata, 1966), OG1968 Mexico City; *n* = 21, *M* = 17.8, (De Gray at al., 1974), OG1972 Munich; *n* = 133, *M* = 19 (Hirata, 1979a,b), WC1974 Varna *n* = 106, *M* = 18.5 (Zaharieva, 1979), OG1976 Montreal; *n* = 99, *M* = 18.2 (Lopez et al., 1979), WC1983 Budapest; *n* = 161, *M* = 16.8 (Gajdoš, 1984), OG1984 Los Angeles; *n* = 75, *M* = 17.2 (Staub, 1986), WC1985 Montreal; *n* = 52, *M* = 16.7 (Staub, 1986); WC1987 Rotterdam; *n* = 201, *M* = 16.5 (Claessens et al., 1991, 1999). Škrelj (1934) carried out the characteristics of anthropometric variables for the Sokol gymnasts in (1933; *n* = 186; age *M* = 21.86 years). Unfortunately, Škerlj (1934) did not provide measures of standard age deviation in order to make calculations of statistical differences between then and now. Čuk and Karácsony (2002) in his book „Rings" presented the previous research on age in timeline from 1964 until 1980 were conducted by Rozin & Čeburaev (1981) and showed age of top male gymnasts at the OG [OG1964, (*M* = 25.6, *SD* = 2.9); OG1968, (*M* = 24.2, *SD* = 3.4); OG1972, (*M* = 24.6, *SD* = 2.8); OG1976 (*M* = 23.3, *SD* = 4.0); OG1980, (*M* = 23.2, *SD* = 3.1)]. Minimum age for participants was 13.0 years at the WC1987 and raised to 16.0 years at the 1997 WC. Mean ages have since increased: 16.5 (WC1987), 17.4 (WC1997), 18.0 (OG2000), and 18.8 (OG2008) years (Claessens, 2007; Malina et al., 2013). The demands of the Olympic gymnastics have continued to escalate,

and currently, a light, powerful, and usually, petite athlete is optimal (Arkaev & Suchilin, 2004, Atiković & Smajlović, 2011). In 2000, a World Cup in male Gymnastics was organised in Ljubljana (Slovenia). The meeting was attended by *n* = 40 competitors. This event presented an opportunity for Čuk & Karácsony (2002) to measure physical characteristics of top male gymnasts. Authors presented characteristics of anthropometric variables for contemporary gymnasts in 2000 [*n* = 40, age *M* = 23.40, *Min* = 17, *Max* = 30]. The results of the male data are presented other authors (Claessens et al., 1991): OG1928 Amsterdam; *n* =19 , *M* = 25.0, Polish gymnasts (Dybowska & Dybowski, 1929), OG1948 London; *n* = 15, *M* = 24.5, (Cureton, 1951), OG1964 Tokyo; *n* = 122, *M* = 26.0, Danish gymnasts (Hirata, 1966, 1979a,b), OG1968 Mexico City; *n* = 28, *M* = 23.6, (De Gray *at al*., 1974), OG1972 Munich; n=126, M=24.7 (Hirata, 1979a,b), WC1974 Varna, *n* = 126, *M* = 23.8, (Zaharieva, 1979), OG1976 Montreal; *n* = 101, *M* = 23.4 (Hirata, 1979), WC1983 Budapest; *n* = 169, M=22.0 (Gajdoš, 1984), WC1987 Rotterdam; *n* = 165, M=21.9 (Claessens et al., 1991, 1999). An analysis of all the female US Olympic gymnastics teams by (Sands et al., 2012), found that when using linear correlations height, mass, age, BMI have been declining since 1956. This is similar to the result you will see below in the analysis of just the Olympic champions. However, against this trend, second-order polynomial curve fits indicated that in the last four Olympic Games the gymnastics have been getting larger.

The results of the authors (Možnik, Hraski, & Hraski, 2013) analyses the differences in age of the top-level male gymnasts in relation to their classification at the WC 2007 and 2011 in year, after one Olympic period. In order to calculate the differences between the age they have found differences between WC 2007 on (RI *p* = .02, VT *p* = .01 i PB *p* = .01). The results of independent *t* test for three comparisons PH-RI were significant, *t* test (70) = 2.19, *p* = .02, PH-PB were significant, *t* test (70) = -2.52, *p* = .01, FX-PB were significant, *t* test (70) = -2.18, *p* = .03. Number of athletes competing in each sport OG2012 and as a percentage of the total. Artistic gymnastics n=198 or 1.8% all athlets at OG2012 (*n* = 10881). Artistic gymnastics 2012 (average age female 18.52 years, male 22.64 years (The Guardian, 2012). The current study aims to investigate historical analysis of the chronological age trend of all participants of women's artistic gymnastics who have won medals in the period between 1928 and 2016 has been made.

Design

A historical analysis of the chronological age trend of all participants of women's artistic gymnastics who have won medals in the period between 1928 and 2016 has been made.

Methods

Subjects

The examinees were gymnasts who had won medals at the following competitions:

Table 1. Olympic Games (OG) from 1928 to 2016 (n = 655).

Events for women	Abbreviations	Gold	Silver	Bronze	SUM	missing in percentages %
All-around individual (AAI)	OGAAI	17	18	17	52	0
Team (TEAM)	OGTEAM	132	132	129,-3	393,-3	-0,75
Vault (VT)	OGVT	18	17	17	52	0
Uneven bars (UB)	OGUB	18	18	17	53	0
Balance beam (BB)	OGBB	18	18	16	52	0
Floor (FX)	OGFX	20	13	20	53	0

Table 2. World Championships (WC) from 1934 to 2015 (n = 997).

Events for women	Abbreviations	Gold	Silver	Bronze	SUM	missing in percentages %
All-around individual (AAI)	OGAAI	34	31,-1	33,-1	98,-2	-2,00
Team (TEAM)	OGTEAM	164,-9	159,-24	156,-25	479,-58	-10,80
Vault (VT)	OGVT	36	37,-1	30,-1	103,-2	-1,90
Uneven bars (UB)	OGUB	43	30	32	105	0
Balance beam (BB)	OGBB	34	37,-1	36	107,-1	-0,92
Floor (FX)	OGFX	38	31	36,-1	105,-1	-0,94

Data collection

All the data concerning the medallists were gathered at: Wikipedia Olympic Games 1928-2016, Wikipedia World Championships 1903-2015 Longines page for results and bulletins in AG.

The International Gymnastics Federation (FIG), National Gymnastic federations of the country that won medals or received by e-mail from the General federation's secretary, over direct contact or over e-mail.

Statistical Analysis

Data processing in this research and the application of the statistically mathematical procedures were conducted in the programme package of Microsoft Office Excel 2013 and SPSS 23.0 (SPSS Inc., Chicago, IL, USA). For calculating the chronological age the following 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:

Calculation formula = DATEDIF (A1; B1; "d")

For the total number of years of one's age since the date of birth until the first day of the competition qualifications:

Calculation formula = DATEDIF (days x 0.0027397260273973 years)

For the total number of years, months and days since the date of birth until the first day of the competition qualifications:

Calculation formula = DATEDIF (A1; B1; "Y") & "years", &DATEDIF (A1; B1; "YM")&" months, "&DATEDIF (A1; B1; "MD") &" days"

Descriptive statistics (mean and standard deviation) are presented for individual apparatuses, team and competition years in Table 3. In order to check for any deviation from normality, a number of methods can be used. One method is to use skewness and kurtosis. Normality can be a problem when the sample size is small (< 50). As can been seen in Tables 3, for the pruposes of conducting a *t*-test (i.e., Skewness < |2.0| and Kurtosis < |9.0|; Schmider, Ziegler, Danay, Beyer, & Bauhner, 2010. Additionally, the assumption of homogeneity of variances was tested and satisfied via Leven's *F* test. An independent t test was conducted to determinate if a difference existed between the chronological age of the participants of the Olympic Games and World Championships. Additionally, the assumption of homogeneity of variances was tested and satisfied via Leven's *F* test. An independent *t* test was conducted to determinate if a difference existed between the chronological age of the all participants of the Olympic Games and World Championships. Cohen's *d* is an effect size used to indicate the standardised difference between two means. The calculations use the 5% level of significance are presented in Table 3. Second-order polynomial curve fits indicated Olympic Games and World Champioship. The best model fit for the historical data was determined by the highest R2 value. Second-order polynomial equations are presented in the Graph 1-3.

Results

The youngest female medallist at the Olympic Games was Nadia Comăneci (ROU) who was 14.61 years of age - 1976 Montreal on UB1, BB1, FX3 and AAI1. The oldest female medallist at the Olympic Games was Ágnes Keleti (HUN) who was 35.89 years of age - 1956 Melbourne on UB1, BB1 and AAI2. The youngest team to win a medal at the Olympic Games was Italy (ITA) in Amsterdam in 1928 with an average age of 14.44 years of age. The oldest team to win a medal at the Olympic Games was the Soviet Union (URS) in Helsinki in 1952 with an average age of 28.62 years of age. The youngest medallists at the World Championship were: Daniela Silivaş (ROU) 13.50 years of age - 1985 Montreal at UB1 13.81 years of age - Olga Mostepanova (URS) 1983 Budapest FX2, AAI2. The oldest medallists at the World Championship were: Ágnes Keleti (HUN) 33.49 years of age - 1954 Rome on UB1, BB3, Oksana Chusovitina (GER) 36.33 years of age - 2011 Tokyo at VT2. The youngest team to win a medal at the World Championship was the United States in Indianapolis in 1991 with the average age of 14.93 years of age. The oldest team to win a medal at the World Championship was Hungary in Rome in 1954 with the average age of 27.58 years of age. In (Table 3) the central and dispersal result parameters from the Olympic Games have the highest result span defined on AAI, UB, BB 21.28 years of age and the lowest on FX with 16.49 years of age.

Analysing the parameters of the central tendency of minimum and maximum value we can establish that certain apparatuses have greater distinctions between the mentioned parameters. The lowest value is on AAI, UB, BB 14.61 years of age and the highest on AAI, UB, BB 35.89 years of age. Analysing the results in arithmetical environments of all variables the highest values were recorded on VT 20.80 years of age while the lowest were measured on FX 20.24 years of age. The highest value of the standard deviation of 4.93 was recorded on BB and the lowest of 4.14 years of age on FX. In (Table 3) central and dispersal result parameters from the World Championships have the highest result span on WCVT 21.45 years of age and the lowest on WCUB 18.90 years of age. Analysing the parameters of the central tendency of minimum and maximum value we can establish that certain apparatuses have somewhat greater distinctions between the mentioned parameters. The lowest value was on WCBB 13.50 years of age and the highest value was on WCVT 36.33 years of age. Analysing the results in arithmetical environments of all variables the highest values were recorded on WCVT 19.79 years of age, and the lowest on WCBB 18.38. The highest value of the standard deviations was on VT 4.17 and the lowest on FX 3.46 years of age. The results in (Table 3) of independent t test were significant, t test (144) = 1.91, p = .05, d = .31, r = .15, indicating that there are significant differences between OGAAI (M = 20.69, SD = 4.85, n = 50) and the scores from WCAAI (M = 19.25, SD = 3.96, n = 96). The effect size, r was very small. The results of independent t test were significant, t test (137) = 2.07, p = .04, d = .35, r = .17, indicating that there are significant differences between OGUB (M = 20.35, SD = 4.88, n = 48) and the scores from WCUB (M = 18.72, SD = 4.12, n = 91). The effect size, r was very small. The results of independent t test were significant, t test (143) = 3.45, p = .00, d = .57, r = .27, indicating that there are significant differences between OGBB (M = 20.88, SD = 4.93, n = 48) and the scores from WCBB (M = 18.38, SD = 3.62, n = 97). The effect size, r was small. The results of independent t test were significant, t test (143) = 2.34, p = .02, d = .39, r = .19, indicating that there are significant

differences between OGFX (*M* = 20.24, *SD* = 4.14, *n* = 48) and the scores from WCFX (*M* = 18.71, *SD* = 3.46, *n* = 97). The effect size, *r* was very small. The results of independent *t* test were significant, *t* test (145) = 2.55, *p* = .01, *d* = .42, *r* = .20, indicating that there are significant differences between the OG team (*M* = 20.22, *SD* = 3.50, *n* = 60) and scores of the WC team (*M* = 18.82, *SD* = 3.09, *n* = 87). The effect size, *r* was small. The two groups of gymnasts differed significantly in the following variables of the Olympic Games and World Championships: AAI, UB, BB, FX, TEAM and the level of significance of (*p* < 0.05).

Table 3. Olympic Games and World Championships in Women's Artistic Gymnastics.

Event	Olympic Games		World Championships		t-test for Equality of Means				
	N	Mean±SD	N	Mean±SD	t	df	P	d	r
AAI	50	20.69±4.85	96	19.25±3.96	1.91	144	.05*	.31	.15
VT	49	20.80±4.49	93	19.79±4.17	1.33	144	.18	.22	.11
UB	48	20.35±4.88	91	18.72±4.12	2.07	137	.04*	.35	.17
BB	48	20.88±4.93	97	18.38±3.62	3.45	143	.00*	.57	.27
FX	48	20.24±4.14	97	18.71±3.46	2.34	143	.02*	.39	.19
TEAM	60	20.22±3.50	87	18.82±3.09	2.55	145	.01*	.42	.20
AAI1	17	20.16±4.25	33	19.57±4.17	.46	48	.64	.13	.06
AAI2	17	21.80±6.07	31	18.50±2.92	2.54	46	.01*	.75	.03
AAI3	16	20.07±4.05	32	19.65±4.57	.30	46	.75	.09	.04
VT1	17	20.40±3.79	34	19.39±3.66	.91	49	.36	.26	.12
VT2	16	22.62±5.57	31	20.26±4.97	1.47	45	.14	.44	.21
VT3	16	19.39±3.52	28	19.74±3.86	-.29	42	.76	-.09	.04
UB1	17	20.42±5.41	34	18.48±3.73	1.49	49	.14	.42	.20
UB2	16	19.54±3.98	27	18.64±4.45	.66	41	.50	.20	.10
UB3	15	21.13±5.32	30	19.06±4.34	1.39	43	.17	.42	.20
BB1	17	20.84±5.62	34	18.54±3.59	1.78	49	.08	.50	.24
BB2	16	21.07±4.83	33	18.48±3.56	2.12	47	.03*	.61	.29
BB3	15	20.72±4.53	30	18.10±3.81	2.03	43	.04	.62	.29
FX1	17	20.82±5.03	34	18.72±3.34	1.77	49	.08	.50	.24
FX2	14	21.24±4.61	30	18.84±2.92	2.10	42	.04*	.64	.30
FX3	17	18.83±2.09	33	18.58±4.08	.23	48	.81	.06	.03
TEAM1	20	20.50±3.67	30	18.88±3.22	1.64	48	.10	.47	.23
TEAM2	20	19.78±3.56	28	18.41±2.90	1.45	46	.15	.42	.21
TEAM3	20	20.39±3.41	29	19.16±3.20	1.29	47	.20	.37	.18

Abbreviations: N = the number of participants, Values are means ± SD, t = T Test Value, df = Degrees of Freedom, * indicates a significant difference, d = Cohen's d Value (Standardized Mean Difference), r = Effect Size [(± 0.1 = very small, Sawilowsky, 2009); (± 0.20 = small, Cohen, 1988); (± 0.50 = medium, Cohen, 1988); (± 0.80 = large, Cohen, 1988); (± 1.2 = very large, Sawilowsky, 2009); (± 2.0 = huge, Sawilowsky, 2009].

In (Table 3) central and dispersal result parameters from the Olympic Games have the highest result span on UB1 and BB1 21.28 years of age and the lowest on FX3 7.58 years of age. Analysing the parameters of the central tendency of minimum and maximum value we can establish that certain apparatuses have somewhat greater distinctions between the mentioned parameters. The lowest value is 14.61 years of age on AAI, UB1, BB1 I FX3 and the highest value of 35.89 years of age on UB1 and BB1. Analysing the results in arithmetical environments of all variables the highest values were recorded on VT2 22.62 years of age, and the lowest on FX3 18.83 years of age. Central and dispersal result parameters from the WC have the highest result span at WCVT2 21.07 years of age and the lowest at WCFX2 10.59 years of age. Analysing the parameters of the central tendency of minimum and maximum value we can establish that certain apparatuses have somewhat greater distinctions between the mentioned parameters. The lowest value is 13.50 years of age at the WCBB1 and the highest value at 33.49 years of age at WCBB3.

Analysing the results in arithmetical environments of all variables the highest values were recorded at the WCVT2 20.26 years of age, and the lowest at the WCBB3 18.10 years of age. The results in (Table 3) of independent *t* test were significant, *t* test (46) = 2.54, *p* = .01, *d* = .75, *r* = .03, indicating that there are significant differences between OGAAI2 (*M* = 21.80, *SD* = 6.07, *n* = 17) and the scores from WCAAI2 (*M* = 18.50, *SD* = 2.92, *n* = 31).

The effect size, *r* was very small. The results of independent *t* test were significant, *t* test (47) = 2.12, *p* = .03, *d* = .61, *r* = .29, indicating that there are significant differences between OGBB2 (*M* = 21.07, *SD* = 4.83, *n* = 16) and the scores from WCBB2 (*M* = 18.48, *SD* = 3.56, *n* = 33). The effect size, *r* was small. The results of independent *t* test were significant, *t* test (42) = 2.10, *p* = .04, *d* = .64, *r* = .30, indicating that there are significant differences between OGFX2 (*M* = 21.07, *SD* = 4.61, *n* = 14) and the scores from WCFX2 (*M* = 18.84, *SD* = 2.92, *n* = 30). The effect size, *r* was small.

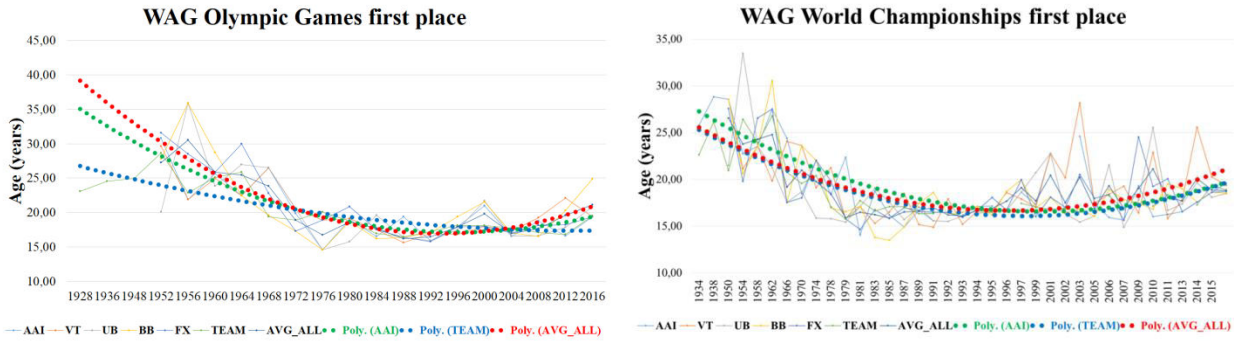

Figure 1. Trending ages of WAG gymnasts - first place.

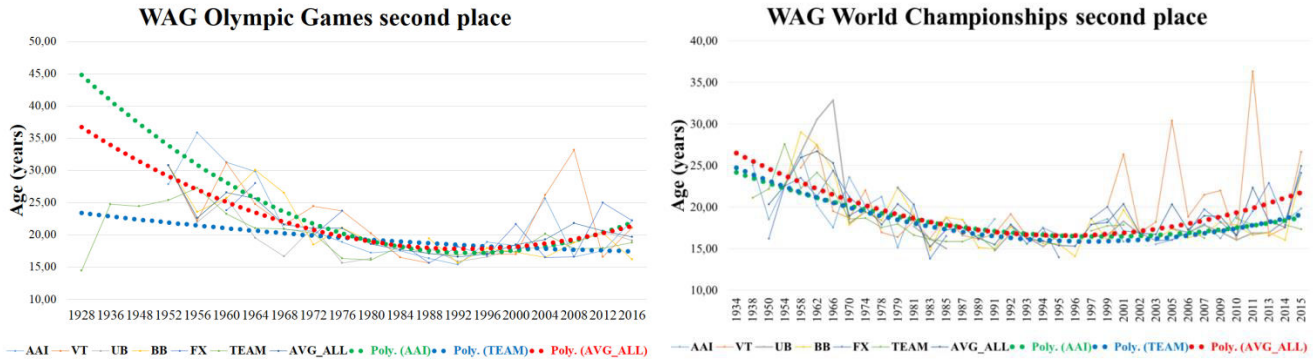

Figure 2. Trending ages of WAG gymnasts - second place.

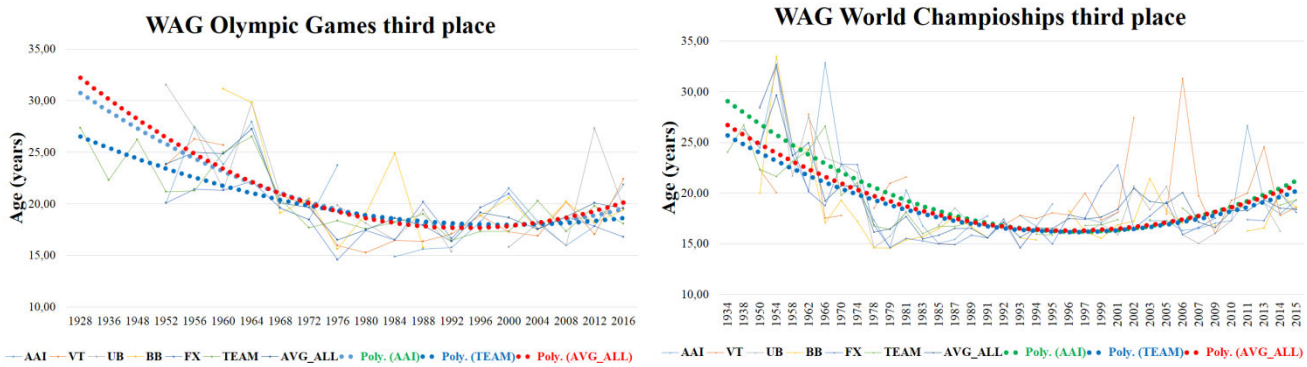

Figure 3. Trending ages of WAG gymnasts - third place.

Discussion

If we compare the age of the WAG by disciplines, the oldest gymnasts are on the BB with an average age on (OG: 20.88 ± 4.93) and on VT (WC: 19.79 ± 4.17) years old, and the youngest in the FX (OG: 20.24 ± 4.14) and BB (WC: 18.38 ± 3.62). The increased complexity of CoP in terms of difficulty value and an increased number of deductions, according to need longer competitive internship to be successful in the gymnastics community (Atiković, 2014). For example, compared to 40 years ago, we see that the exercises are more composed of the elements of grace, partly of the ballet. In order to be successful in their performance, according to the new regulations for the assessment, gymnasts have to combine elements of technical complexity with difficulties of the Code of Points FIG (weight, bonification, special requirements, composition, bonus points and execution). Such elements of the extraordinary complexity must be constantly improved and practiced for, over long period of time. Sports gymnastics is a branch of gymnastics with the primary requirement of adopting the most diverse techniques of specific exercises. This means that learning new, more complex and more demanding elements is daily principle of training process which increases the very length of training (Atiković, 2014). In recent years, gymnastics has shown great evolution due to materials and apparatus development, as well as to training methods improvement (Nunomura, Pires, & Carrara, 2009). Moreover, complexity increased in their implementation and motor demand, fact that determined an increase in daily training hours (Nunomura, Pires, & Carrara, 2009, Caine, Russel, & Lim, 2013).

Today experts believe that the hours of training have tripled (from 2 hour training a day in the 30s to 5-6 hour training sessions in the modern era). Arkaev and Suchilin (2004) reported that gymnasts train 1500 hours per year in 300-310 days. Average time training reported by gymnasts at major championships was 30 h/week, but variation was considerable (Georgopoulos et al., 2002, 2004; Markou et al., 2004). Overall, reported weekly time in training overlaps in females and males, and increases with age and level of competition. Weekly training in gymnastics schools of the former Soviet Union increased, for example, from 8 h/week in initial training at 5–6 years of age to 32–36 h/week for elite training at 16–18 years (Hartley, 1988). The 'optimal plan' for training elite US female gymnasts, for example, suggests two daily sessions (morning 2–3 h, afternoon 3–4 h), 6 days per week (USA Gymnastics, 2011). Allowing for age (junior pre-elite 11–14 years, junior elite 11–15 years, senior elite C16 years), the 'optimal plan; translates to 30–42 h/week plus 1 h of dance training at least twice per week by a dance professional familiar with needs of artistic gymnastics (USA Gymnastics, 2011). By comparison, elite and advanced US female youth gymnasts in the 1980s trained 20–27 h/week through the year (Caine et al., 1989), while contemporary elite level gymnasts train 20–30 h/week, 45–48 weeks per year (Russell K, unpublished observations).

Training loads and sequencing of training activities are highly variable among individuals, which limit comparisons. Variation among individuals in responsiveness to gymnastics training has not been systematically considered. Gymnasts on floor expose their body to extremely demanding conditions of training and competition that involves motor skills of particular explosive strength and jumping ability type coordination, and their body dissipation, in regard to such big efforts, is accelerated. For this reason, it is not surprising that gymnasts on the FX achieve their best results, on average, at the OG and WC at the age of 23 years old. These results suggest that the gymnasts, who pretend to the entrance into the finals at the WC and OG, according to their age and body structure, differ from the gymnasts who perform in other disciplines and who place themselves from first to third place in the biggest world competitions. According to, most movements in the rings require shoulder abduction and consequent capsular compression in order to keep joint stability (Carrara and Mochigueki, 2008). Nunomura (2002), reported that each apparatus presents unique characteristics. Moreover, in recent years, complexity increased in their implementation and motor demand, fact that determined an increase in daily training hours (Nunomura, 2002, Caine, Russel, & Lim 2013). According to the author (Nunomura, 2008) floor is the one most complex apparatus in artistic gymnastics and it is composed of acrobatic elements combined with gymnastic strength and balance exercises.

Floor exercise demands are linked to strength (muscle power in the lower and upper limbs), exibility, and muscular anaerobic endurance. Forces experienced during take-offs and landings in artistic gymnastics can be very high. Forces measured at landings can range from 3.9 to 14.4 times the gymnast's body weight (Panzer, 1987; McNitt Gray, 1993). The highest forces measured when performing double back somersaults ranged from 8.8 to 14.4 times the gymnast's body weight. This was 6.7 times more body weight compared to back somersault. Karacsony and Čuk (2005) found that forces at take off at different somersaults can be up to 13.9 times the participant's body weight. It is one of the reasons short sports career at the FX. A lot has changed, for instance an increased complexity in movements on apparatuses. For example, in 2001, the traditional vaulting horse was replaced by a new vaulting table. This new vaulting table is more elastic, bigger and more stable. This resulted in a safer apparatus than the old traditional vaulting horse.

Therefore, the routines that gymnasts perform could become more difficult and spectacular; higher difficulty scores and more twisting. Gymnast specialists on that apparatus is possible that for a long time can to remain active as competitors. It is no coincidence that the oldest women in the discipline. The balance beam is one of the most difficult gymnastics apparatuses in womans artistic gymnastics requiring great concentration and the highest training frequency. Balance is a fundamental ability of human movement. All the athlete has to do is keep her center of mass over the (10 centimeters) beam in order to balance. In other words, she could just stand there and not fall off, but it would be a rather uninteresting physics problem (and sport). Instead, gymnasts spin, twist and kick on the balance beam, testing the boundaries of the simple physics principle that could easily keep them stable. The balance beam balance is extremely important in executing complex acrobatic elements, as well as dance elements (Delaš Kalinski, Božanić, & Atiković, 2011).

Female gymnast today needs much more time training them to be successful as a contestant with previous ages because he needs a much higher number of repetitions technical of demanding elements to perfection in the competition. The assumption was that the new Code of Points would enhance the maturity of international-level female gymnasts and, concomitantly, reduce the stress and potential injury risk to the gymnasts, as well as add an emphasis on elegance and acrobatics (Sands et al., 2012). However, the age limitations were introduced to gymnastics for: physiological reasons, protecting children from harmful exposure, time training, early growth, growth of body segments, pubertal growth and maturation, sex characteristics, menarche, nutritional status, weight-for-height, gymnastics training environment, familial factors (Anderson, 1997; Paul, 2010).

Conclusion

According to the results presented and discussed herein, the following conclusions can be drawn:

1) in 1996, there was a declining trend in the age to after this period has started to increase and this trend is ongoing;
2) changes in the General Rules and Code of Points by FIG have influenced age rise compared to the previous Olympic cycles;
3) female gymnasts ended their carriers in the past earlier, while today we have some athletes in professional gymnastics who are over 30-35 years of age;
4) as it can be noted, in the past, there was a noticeable downward trend in age of female participants of the OG and WC.

In the upcoming period we do expect (with apparatus specialization) age will be slightly higher.

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PROMJENA ZAHTJEVA MINIMALNOG UZRASTA I PROMJENE KOJE SU SE DESILE U GLAVNOM NATJECANJU ŽENSKE SPORTSKE GIMNASTIKE

Sažetak

Olimpijske igre (OG) i Svjetska prvenstva (WC) predstavljaju krunu karijere svakog sportaša, tako je isto sa gimnastičarkama. Cilj ovog istraživanja je bio istražiti povijesnu analizu u kronološkoj dobi i trend svih sudionica u ženskoj sportskoj gimnastici koje su osvojile medalje u razdoblju između 1926. i 2016. godine. Ispitanice su bile gimnastičarke koji su osvojile medalje na slijedećim natjecanjima: OG od 1926. do 2016. godine (n = 655) i WC od 1934. do 2015. godine (n = 997). Ako usporedimo kronološku starost po disciplinama, najstarije gimnastičarke su bile na gredi s prosječnom dobi od (OI 20.88 ± 4.93) i na preskoku (SP 19.79 ± 4.17), a najmlađe u parteru (OI 20.24 ± 4.14) i na gredi (SP 18.38 ± 3.62) godina. Rezultati nezavisnog t-testa pokazali su značajne razlike između OI i SP u višeboju (AAI), preskoku (VT), dvovisinskim ručama (UB), gredi (BB), tlu (FX) i drugo mjesto na AAI, BB i FX. Budući svaki olimpijski ciklus postaje sve više zahtijevan u smislu složenosti i težinskih vrijednosti elemenata, očekuje se da je gimnastičarkama potrebno više vremena da steknu stabilnost, iskustvo i sigurnost pri izvedi složenih vježbi u budućnosti.

***Ključne riječi**: t-test, Cohenov d, veličine efekta r, ženska sportska gimnastika*

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