

AGE TRENDS IN ARTISTIC GYMNASTIC ACROSS WORLD CHAMPIONSHIPS AND THE OLYMPIC GAMES FROM 2003 TO 2016

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Abstract

The aim of research was to analysis development and age structure of male and female participants at the Olympic Games (OG) and World Championships (WC) from 2003 until 2016. The total number of analyzed WC participants in men's artistic gymnastics (MAG) was 2678 and the women's artistic gymnastics (WAG) was 1981; while at the OG in MAG 391 and in WAG 389. In the last 15 years, there has been identified linear and second-order polynomial-regression increase in the age structure of participants in MAG and WAG in the largest world competitions. In analyzed period of time, MAG and WAG age of gymnasts increased. The male gymnasts from 2003 to 2016 are on average older for 2.3 years and female gymnasts for 3.3 years. In the upcoming period, we do expect (with apparatus specialization) that age will rise.

Keywords: *artistic gymnastics, Code of Points, development, men, women.*

INTRODUCTION

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. Long term development applies to all levels of participants and in all gymnastics disciplines. Scientific research (Drabik, 1996; Rost & Schon, 1997, Hofmann, 1999; Bompá, 1999, Arkaev & Suchilin, 2004; Balyi et al., 2005; Malina, 2010; Fink & Hofmann, 2015; Fink, Hofmann, & Ortiz Lopez, 2015) has concluded that it takes a minimum of ten years, 10,000

hours of deliberate training for a talented athlete to reach elite levels. This translates into an average of more than 3 hours of training daily for 10 years. There are no shortcuts; athlete development is a long term process.

Artistic Gymnastics in the 1950s and 1960s, the senior competition was dominated by athletes in their mid-to-late twenties. At the time, the "Code of Points" aimed more on artistry and was largely inspired by ballet. As a result, more seasoned gymnasts found success in the sport by bringing elegance to their routines. Up until 1981 the minimum age

for participating in senior competitions was 14 years of age. In 1981, gymnasts were required to turn at least 15 years of age in the calendar year to compete in senior-level events. Since 1997, the Fédération Internatio-nale de Gymnastique, the gymnasts had to be at least 16 years old or to be turning 16 within the calendar year in order to take part in the competition as seniors. The age limit for participation at a world championship has been moved up. Today, the limit sits at 18 for MAG and 16 for the WAG (Sands et al., 2012; Grossfeld, 2014; FIG Technical Regulations 2017, Art. 5.2. Pg. 37).

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. There is also the concern that imposed training limits could lead to more injuries (Anderson, 1997; Paul, 2010, Sands et al., 2012).

Research on age in timeline from 1964 until 1980 were conducted by Rozin & Čeburaev (1981) and showed age of top male gymnasts at the Olympic Games [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 MAG participants was 13.0 years at the WC1987 and rose to 16.0 years at the 1997 WC. The age of men have since increased: 16.5 (WC1987), 17.4 (WC1997), 18.0 (OG2000), and 18.8 (OG2008) years (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).

Authors (Sands et al., 2012) state in the conclusion, that the US Women Olympic gymnasts were getting approximately smaller through the 1980s

and early 1990s. Since then, the size of these gymnasts has increased. The minimum age rule modifications may have played a role in the athlete size changes along with a shift from the near dominance of the former communist Eastern Bloc (Sands et al., 2012).

In this research (Andreev, 2015) try to analyze different age aspects of 143 elite male gymnasts, Olympic medal holders for the time period 1960 – 2012. The average starting age to practice artistic male gymnastics is dropping more than 50% 14 to 6.2 from the beginning to the end of the researching time period 1960-2012. The average retirement age also has a trend of decreasing from the age of 36 to 26.4 or nearly 10 years. The average Olympic medal age is rejuvenating from 27 in Rome'60 to the age of 23.3 in London'12 and the "golden" age to earn the Olympic medal in male artistic gymnastics is 24. The rings are the "oldest" apparatus with an average age of 25.1 for medallists and the floor exercise is the "youngest" – 23.

Atiković, Delaš Kalinski and Smajlović (2017) in this study it was investigate the historical analysis of the chronological age trend of all participants of men's artistic gymnastics who have won medals in the period between 1896 and 2016 has been made. The oldest gymnasts are on the Rings with an average age on (OG: M = 26.48, SD = 3.85) and (WC: M = 40.23, SD = 3.50) years old, and the youngest in the same are contestants (OG: Floor = 23.09, SD = 3.88) and (WC: M = 7.86 SD = 4.02). The results of independent *t* test were significant difference between OG and WC on Pommel horse (PH), Rings (RI), Paralell bars (PB), All-around individual (AAI) first place and Paralell bars (PB) first place.

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 and coaches need more time to acquire stability, experience and safety

when performing such complex exercises. According to the first FIG CoP 1964 to the present, the MAG and WAG has already gone through 14 versions or cycles CoP. Atiković (2014) emphasizes that the changes in the regulation of men's and women's artistic gymnastics occur from one cycle to another by changes in evaluation of difficulty value (DV) from cycle to cycle: 1956-1976: A-C; 1979: A-C^r; 1985-1989: A-D; 1992: A-E, 1996-7: A-E, 2001: A-super E; 2006: male: A- F, female: A-G; 2009: A-G, 2013 male: A-G, female: A-H. Every element was awarded a specific difficulty rating, ranging from A (easiest) to I (hardest) in the table of elements. Gymnast earned bonus points by performing difficult skills alone or in combination (FIG, 2017^{a,b}).

The increased complexity of CoP, in terms of difficulty value and increased number of deductions, require gymnast's longer competitive internship, in order to be successful in the gymnastics community. Some gymnasts and gymnasts such as Oksana Chusovitina and Yordan Yovchev, succeeded the age of 40 to be ranked high in major competitions. Oksana Chusovitina competed at her seventh Olympics in year 2016, another record, at the age of 41. Bulgaria's Yordan Yovchev (39 years old) became the first male gymnast to ever compete in six OG.

The aim of this research is to analyze different age aspects of male and female participants at the Olympic Games and World Championships from 2003 until 2016, and to determine the differences in the age structures between particular competitions and disciplines in male and female artistic gymnastics. The studies concerning different age aspects among elite athletes sports longevity in seniors gymnastics.

METHODS

All the participants in MAG are presented in the following competitions: WC2003, N=318; WC2005, N=177;

WC2006, N=278; WC2007, N=253; WC2009, N=243; WC2010, N=299; WC2011, N=262; WC2013, N=261; WC2014, N=311; WC2015, N=276; and in WAG: WC2003, N=224; WC2005, N=95; WC2006, N=223; WC2007, N=214; WC2009, N=146; WC2010, N=218; WC2011, N=216; WC2013, N=134; WC2014, N=250; WC2015, N=261. The sample of the examinees also included all the participants in MAG in the following competitions: OG2004, N=98; OG2008, N=98; OG2012, N=98; OG2016, N=97; and in WAG: OG2004, N=98; OG 2008, N=97; OG2012, N=96; OG2016, N=98. The total number of analyzed WC participants in MAG amounted to N=2678 and the WAG was N=1981; while at the OG with MAG N=391 and the WAG N=389.

We have made historical analysis of the chronological age trend from the official book results of the Fédération Internationale de Gymnastique (FIG) of all male and female participants in men's artistic gymnastics and women's artistic gymnastics for the period of 2003 to 2016.

The intent was to collect current data of female and male gymnasts from recent years. All data for this study was obtained from the Longines ranking website and official websites of the OG results Longines Official Results Books 2003 - 2016

<http://www.longinestiming.com/#!/gymnastics/> (Accessed 1 Sep 2016) & Official Website of the Olympic Games Results 2004-2016

<https://www.olympic.org/olympic-results> (Accessed 1 Sep 2016). These two web pages record all gymnastics results according to events, such as WC and OG. We started collecting data from the WC2003 and ended with the OG2016, because previous data was not available for analysis or it was not complete. The following variables were included: date of birth, qualification date of the OG, qualification date of the WC.

Data processing in this research and the application of the statistically mathematical procedures were conducted in the program 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") (1)

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) (2)

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" (3)

Descriptive statistics for all variables were used. Linear regression methods and second-order polynomial equations were used to determine the best fit for the time series. Several time-series analysis methods were calculated and fitted to the historical data, along with the resulting regression equations and R^2 values using Microsoft Excel 2013. The best model fit for the historical data was determined by the highest R^2 value. An independent sample t test was calculated to determine if whether there is a difference between the chronological age of the all participants of the Olympic Games 2004-2016 and World Championships 2003-2015. Differences in the mean values are treated as statistically significant when the calculated p value was lower than 0.05.

RESULTS

Table 1-2 shows the descriptive information about WC and OG, number of athletes, the year when the competition was held, median value, standard deviations, individually for each of the disciplines.

The results in Table 4 of independent t test were significant; t test (592) = 4.17, $p = .00$, indicates that there are significant differences between MAG WC03 (22.94 ± 3.42 , $n = 318$) and the scores at the MAG WC15 (24.25 ± 4.17 , $n = 276$). The results in Table 4 of independent t test were significant; t test (483) = 7.92, $p = .00$, indicating that there are significant differences between WAG WC03 (17.49 ± 2.32 , $n = 224$) and the scores at the WAG WC15 (19.59 ± 3.33 , $n = 261$). The results in Table 4 of independent t test were significant, t test (194) = 3.91, $p = .00$, indicating that there are significant differences between WAG OG04 (18.73 ± 2.85 , $n = 98$) and the scores at the WAG OG16 (20.79 ± 4.36 , $n = 98$). The results in Table 4 of independent t test were significant, t test (130) = -2.68, $p = .00$, indicating that there are significant differences between WAG TEAM04 (18.33 ± 2.50 , $n = 72$) and the scores from WAG TEAM016 (19.70 ± 3.34 , $n = 60$).

Table 1

Age (years) of the competitors (Mean \pm SD) at the World Championships from 2003 to 2015.

| Events | Year | | | | | | | | | | |
|--------|---------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| | 2003 | 2005 | 2006 | 2007 | 2009 | 2010 | 2011 | 2013 | 2014 | 2015 | |
| | N | 318 | 177 | 278 | 253 | 243 | 299 | 262 | 261 | 311 | 276 |
| Men | FX | 22.68 \pm 3.35 | 22.61 \pm 3.46 | 22.81 \pm 3.80 | 23.26 \pm 4.00 | 22.63 \pm 3.13 | 23.12 \pm 4.06 | 23.73 \pm 3.91 | 22.93 \pm 3.57 | 22.90 \pm 3.35 | 23.89 \pm 3.93 |
| | PH | 22.97 \pm 3.44 | 24.51 \pm 3.20 | 23.14 \pm 3.84 | 23.51 \pm 4.07 | 22.78 \pm 3.24 | 23.33 \pm 4.09 | 23.75 \pm 3.85 | 23.18 \pm 3.87 | 23.16 \pm 3.63 | 24.13 \pm 4.18 |
| | RI | 22.93 \pm 3.43 | 23.62 \pm 3.85 | 23.07 \pm 3.96 | 23.63 \pm 3.99 | 22.93 \pm 3.63 | 23.44 \pm 4.17 | 23.89 \pm 4.05 | 22.79 \pm 3.69 | 23.05 \pm 3.42 | 23.86 \pm 4.03 |
| | VT | 22.84 \pm 3.44 | 22.80 \pm 3.55 | 22.91 \pm 3.86 | 23.23 \pm 4.01 | 22.77 \pm 3.45 | 23.27 \pm 3.92 | 23.89 \pm 4.02 | 22.63 \pm 3.48 | 22.06 \pm 3.55 | 23.99 \pm 4.07 |
| | PB | 22.92 \pm 3.42 | 23.56 \pm 3.78 | 22.95 \pm 3.92 | 23.69 \pm 4.16 | 22.84 \pm 3.47 | 23.37 \pm 4.23 | 23.81 \pm 4.02 | 23.06 \pm 3.97 | 23.04 \pm 3.57 | 24.03 \pm 4.13 |
| | HB | 22.88 \pm 3.42 | 23.34 \pm 3.77 | 22.94 \pm 3.88 | 23.55 \pm 4.11 | 23.19 \pm 3.70 | 23.34 \pm 4.16 | 23.90 \pm 3.94 | 23.17 \pm 3.75 | 23.10 \pm 3.59 | 24.04 \pm 4.11 |
| | ALL MAG | 22.94 \pm 3.42 | 23.63 \pm 3.69 | 22.99 \pm 3.94 | 23.51 \pm 4.16 | 23.30 \pm 3.67 | 23.54 \pm 4.19 | 23.95 \pm 3.99 | 23.82 \pm 3.89 | 23.23 \pm 3.67 | 24.25 \pm 4.17 |
| | N | 224 | 95 | 223 | 214 | 146 | 218 | 216 | 134 | 250 | 261 |
| Women | VT | 17.55 \pm 2.34 | 18.76 \pm 2.51 | 18.48 \pm 2.56 | 18.00 \pm 2.80 | 18.37 \pm 2.23 | 18.42 \pm 2.62 | 19.12 \pm 3.03 | 19.41 \pm 3.43 | 19.36 \pm 3.15 | 19.58 \pm 3.22 |
| | UB | 17.57 \pm 2.37 | 18.67 \pm 2.61 | 18.50 \pm 2.53 | 17.90 \pm 2.73 | 18.57 \pm 2.42 | 18.38 \pm 2.37 | 18.96 \pm 2.78 | 19.23 \pm 2.93 | 19.29 \pm 3.07 | 19.66 \pm 3.35 |
| | BB | 17.60 \pm 2.39 | 18.82 \pm 2.66 | 18.40 \pm 2.51 | 18.00 \pm 2.82 | 18.54 \pm 2.37 | 18.49 \pm 2.59 | 19.03 \pm 2.90 | 19.16 \pm 2.87 | 19.31 \pm 3.14 | 19.62 \pm 3.35 |
| | FX | 17.52 \pm 2.35 | 18.78 \pm 2.30 | 18.40 \pm 2.52 | 17.93 \pm 2.88 | 18.44 \pm 2.28 | 18.23 \pm 2.29 | 19.03 \pm 2.90 | 19.09 \pm 2.80 | 19.08 \pm 2.96 | 19.54 \pm 3.31 |
| | ALL WAG | 17.49 \pm 2.32 | 18.72 \pm 2.66 | 18.37 \pm 2.45 | 17.88 \pm 2.78 | 18.59 \pm 2.38 | 18.47 \pm 2.60 | 19.01 \pm 2.97 | 19.44 \pm 3.39 | 19.23 \pm 3.07 | 19.59 \pm 3.33 |

Abbreviations: N, Number of participants; M, Mean; SD, Standard deviation; FX, Floor; PH, Pommel horse; RI, Rings; VT, Vault; PB, Parallel bars; HB, High bar; UB, Uneven bars; BB, Balance beam; ALL MAG, All men competitors; ALL WAG, All female competitors.

Table 2

Age (years) of the competitors (Mean \pm SD) at the Olympic Games from 2004 to 2016.

| | Years Events | 2004 | 2008 | 2012 | 2016 |
|-------|-----------------|------------------|------------------|------------------|------------------|
| Men | N | 98 | 98 | 98 | 97 |
| | FX | 24.13 \pm 3.17 | 24.39 \pm 3.1 | 24.32 \pm 3.70 | 24.58 \pm 3.62 |
| | PH | 24.51 \pm 3.20 | 24.63 \pm 3.18 | 24.60 \pm 3.58 | 24.49 \pm 3.50 |
| | RI | 24.59 \pm 3.21 | 24.57 \pm 3.36 | 24.56 \pm 4.00 | 24.51 \pm 3.44 |
| | VT | 24.21 \pm 3.12 | 24.55 \pm 3.27 | 24.23 \pm 3.89 | 24.69 \pm 3.61 |
| | PB | 24.44 \pm 3.22 | 25.05 \pm 3.50 | 24.70 \pm 3.83 | 24.51 \pm 3.42 |
| | HB | 24.36 \pm 3.04 | 24.74 \pm 3.25 | 24.64 \pm 3.69 | 24.76 \pm 3.88 |
| | ALL MAG | 24.61 \pm 3.25 | 25.06 \pm 3.49 | 24.97 \pm 4.09 | 25.24 \pm 3.87 |
| | N TEAM | 72 | 72 | 60 | 60 |
| | TEAM | 24.35 \pm 3.26 | 24.95 \pm 3.19 | 24.06 \pm 3.70 | 25.11 \pm 3.46 |
| Women | N | 98 | 97 | 96 | 98 |
| | VT | 18.61 \pm 2.80 | 18.98 \pm 3.05 | 20.41 \pm 3.75 | 20.41 \pm 4.12 |
| | UB | 18.72 \pm 2.65 | 18.88 \pm 2.94 | 20.22 \pm 3.43 | 20.32 \pm 3.37 |
| | BB | 18.59 \pm 2.54 | 18.89 \pm 3.25 | 20.31 \pm 3.59 | 20.92 \pm 4.46 |
| | FX | 18.50 \pm 2.52 | 18.98 \pm 3.09 | 20.29 \pm 3.36 | 20.49 \pm 3.78 |
| | ALL WAG | 18.73 \pm 2.85 | 19.01 \pm 3.03 | 20.43 \pm 3.65 | 20.79 \pm 4.36 |
| | N TEAM | 72 | 72 | 60 | 60 |
| | TEAM | 18.33 \pm 2.50 | 18.92 \pm 3.24 | 19.69 \pm 3.85 | 19.70 \pm 3.34 |

Abbreviations: N, Number of participants; N TEAM, Number of team participants; M, Mean; SD, Standard deviation; FX, Floor; PH, Pommel horse; RI, Rings; VT, Vault; PB, Parallel bars; HB, High bar; UB, Uneven bars; BB, Balance beam; ALL MAG, All men competitors; ALL WAG, All female competitors.

Table 3

Linear and Second-Order Polynomial-Regression Equations for Individual Athlete Data on Each Variable With the World Championships and Olympic Games Year.

| Variable Age (yrs) | Linear equation | r ² | Second-order polynomial equation | r ² |
|--------------------|------------------|----------------|---|----------------|
| MAG 2003-2016 | y=0.071x+23.402 | 0.146 | y=0.0058x ² -0.016x+23.634 | 0.158 |
| WAG 2003-2016 | y=0.1696x+17.715 | 0.628 | y=0.0083x ² -0.0449x+18.048 | 0.647 |
| MAG OG 2004-2016 | y=0.1386x+24.277 | 0.129 | y=-0.1151x ² -0.4371x+24.853 | 0.200 |
| WAG OG 2004-2016 | y=0.4872x+17.946 | 0.903 | y=-0.1448x ² -1.2114x+17.222 | 0.967 |

Abbreviations: MAG 2003-2016, Men's artistic gymnastics results; WAG 2003-2016, Women's artistic gymnastics results; MAG OG 2004-2016, Men's artistic gymnastics results Olympic Games; WAG OG 2004-2016, Women's artistic gymnastics results Olympic Games.

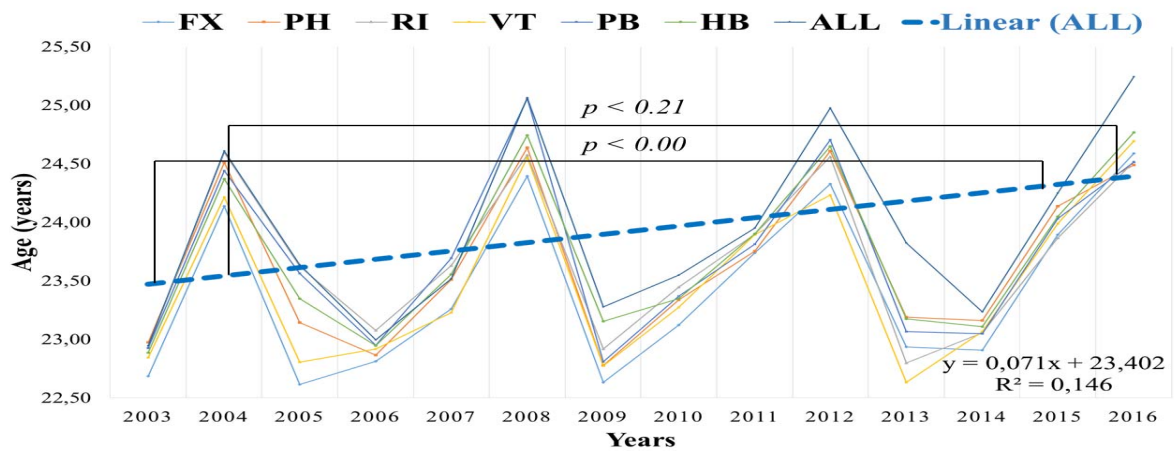
Table 4

Independent t-test for Equality of Means.

| Event | N | Mean \pm SD | N | Mean \pm SD | t | df | p |
|---------------|-----|------------------|-----|------------------|-------|-----|--------|
| MAG WC03-WC15 | 318 | 22.94 \pm 3.42 | 276 | 24.25 \pm 4.17 | 4.17 | 592 | 0.000* |
| MAG OG04-OG16 | 98 | 24.61 \pm 3.25 | 97 | 25.24 \pm 3.87 | -1.23 | 193 | 0.218 |
| WAG WC03-WC15 | 224 | 17.49 \pm 2.32 | 261 | 19.59 \pm 3.33 | 7.92 | 483 | 0.000* |
| WAG OG04-OG16 | 98 | 18.73 \pm 2.85 | 98 | 20.79 \pm 4.36 | 3.91 | 194 | 0.000* |
| MAG TEAM04-16 | 72 | 24.35 \pm 3.26 | 60 | 25.11 \pm 3.46 | -1.29 | 130 | 0.197 |
| WAG TEAM04-16 | 72 | 18.33 \pm 2.50 | 60 | 19.70 \pm 3.34 | -2.68 | 130 | 0.008* |

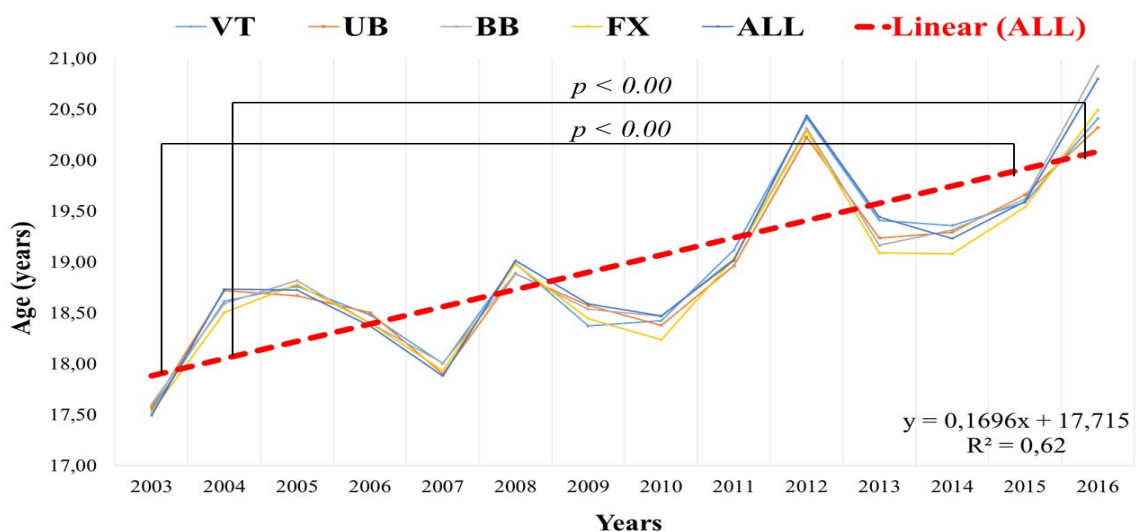
Abbreviations: N, Number of Participants; M, Mean; SD, Standard deviation; t = t test value, df = Degrees of Freedom, *p, indicates a statistically significant difference at p<0.05; MAG, men's artistic gymnastic; WAG, women's artistic gymnastics; WC, World Championship; OG, Olympic Games.

Figures 1 through 3 show the age of the competitors and teams (Mean \pm SD) at the WC and OG 2003–2016. Figures 1 through 3 also show the linear fit curves.



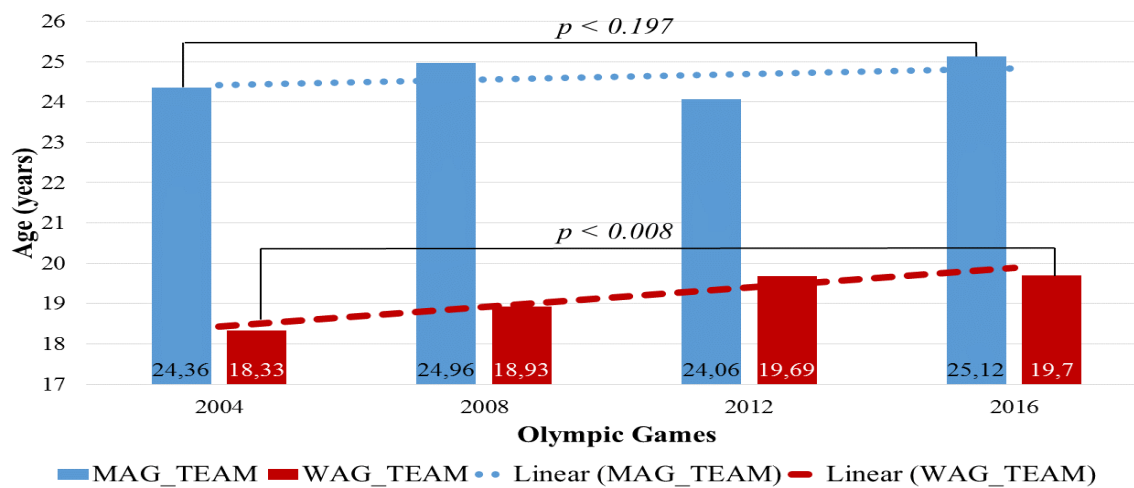
Abbreviations: p, statistically significant difference at $p < 0,05$; FX, Floor; PH, Pommel horse; RI, Rings; VT, Vault; PB, Parallel bars; HB, High bar; ALL, All men competitors; ALL Linear, Linear regression.

Figure 1. Trending ages of men's artistic gymnastics gymnasts from 2003 to 2016.



Abbreviations: p, statistically significant difference at $p < 0,05$; VT, Vault; UB, Uneven bars; BB, Balance beam; FX, Floor; ALL, All women competitors; ALL Linear, Linear regression.

Figure 2. Trending ages of women's artistic gymnastics gymnasts from 2003 to 2016.



Abbreviations: p, statistically significant difference at $p < 0.05$; MAG and WAG all team participants at the Olympic Games; ALL Linear, Linear regression.

Figure 3. Trending ages of men's artistic gymnastics and women's artistic gymnastics team gymnast from 2004 to 2016.

DISCUSSION

In Table 1, the youngest male participants at the WC were recorded in six occasions on the FX 2003-2006 and 2009-2011, then three times on the VT 2007, 2013 and 2014. The youngest female participants at the WC were recorded six times on the FX 2003, 2006, 2010, 2013-2015, three times on the UB 2005, 2007 and 2011. The oldest male participants at the WC were recorded six times on the PH from 2003-2006, 2013-2015, and two times on the HB in 2009 and 2011. The oldest women at the WC were recorded four times on the BB 2003, 2005, 2007 and 2010, three times on the VT 2011-2014.

In Table 2, the results presented are the ones from the oldest male participants of the OG. The oldest were on the PB in 2008 and 2012, while the oldest female was equally represented on all four competitions of the OG. The youngest male participants of the OG were recorded twice on the FX at the OG in 2004 and 2008, while youngest female were recorded three times at the UB 2008-2016. When we look at the values of all twelve participating teams at the OG in MAG and WAG, we can notice a slight tendency of age growth in both competitions.

In Table 3, we have the presented equations for the least-squares best fits of linear and polynomial-regression equations. Note that the general trend over time appears to be a simple linear relationship. The values R^2 are more expressed in WAG compared to MAG both for team competitions and each year and discipline.

Comparing to Rozin & Čeburaev (1981) results from that period and the newer dates, we can see that the gymnasts were older than they are today at the OG and even then we can notice a slight decrease in the age of the athletes. Gaverdovskij (1983) analyzed trends in gymnast's age and their competitive career; his main conclusion was that the age of top gymnasts is lowering and time

of their career is shortening according to their peers between years 1950-1980. However, change of CoP, age limitation changed that rule severely (Figure 4), as gymnast's career is longer, their age is rising again.

Age changes occur systematically from Olympic cycle to cycle. The oldest competitors are at the OG, then there is a decline in the trend of one or two years, and again at the end of the Olympic cycle trend is returning to a higher value than the previous cycle. It should be noted, that for all countries it is the most important competition at the OG. Year after OG, and that in particular, the WC serves as opportunity for young gymnasts to prove themselves on the international scene. Granting, the trend is not reflected to change a whole generation of competitors. In regard to this, it should be noted that the male all-around competitors however are the oldest; and that there are age differences between disciplines in men more than in female, where these differences are very small between disciplines. Based on the arguments presented in the text, it is evident that there has been an increase in the age of more women's artistic gymnastics than in men's artistic gymnastics. The male gymnast from 2003 to 2016 are, on average, older for 2.3 years and for female it is 3.3 years of age and the growth trend continues. Unlike men, women have statistically significant difference in age for the period OG from 2004 to 2016. For women, it is noticed faster uptrend age from Olympic cycle to cycle. International Gymnastics Federation may increase the minimum age of female participants from the current 16 to 17 years old.

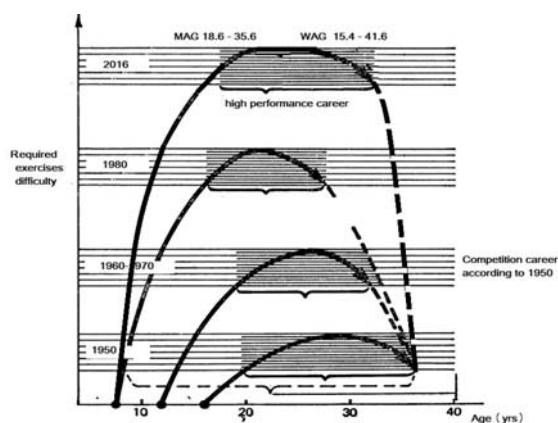


Figure 4. Time of competition career during decades (adopted year 2016, according to Gavardovskij, 1983).

We can compare our results with McCready (2016) research “For Olympic Athletes, Is 30 the New 20?”. According to McCready, it’s no secret that gymnasts across the border and in different countries are getting younger, but we were not aware of the magnitude. Although they have an average age of 23.4 years, which is almost the same as the full study average, it was mainly boosted in the first half of the century. For instance, the average age of gymnasts before the 1960s was above 26 years of age, bringing the average age up significantly. But that trend was about to be busted in a big way in just a few years. During the latter half of the 1960s, we first see the downward trend starting at 23 years of age and continuing until it hits rock bottom at 18 years of age in 1992. After that low point in 1992, the average age settled in at around 21 years of age for the next 20 years. He predicts that the trend will continue into 2016, with the average gymnast being closer to 20 years of age. He looked at the 1952 Olympics and onward because female were not able to compete in Gymnastics prior to 1952. Male gymnasts have been well above the average age trend line since 1952. It almost mirrors the average age trend line in slope for the entire graph, starting with an average age of close to 27 and finally settling at the predicted age of about 22 years of age for 2016. On the other hand,

the trend line for female gymnasts takes more serious and maybe even controversial downward push. Starting at almost the exact same age as the combined trend line of 24.4 years, their trending ages drop almost nine years before finally settling on a projected average of about 16 years of age in 2016 (McCready, 2016).

According to the results presented in Table 4, male participants are getting older at WC2003 – WC2015 but on the OG are not older than before OG2004 – OG2016 (Figure 1). Women are getting older, and among them was a statistically significant change relations to the years WC2003 – WC2015 and OG2004 – OG2016 (Figure 2). Also, for male members of the team, there is no significant difference OG2004 – OG2016, while for women there is a difference between OG2004 – OG2016 (Figure 3).

If we compare the age of the MAG by disciplines, the oldest gymnasts are on rings, and the youngest are on the floor. Static strength is required on the rings; it is obvious that for getting it, a certain period of training is required, according to those needs that the best results on rings are expected only after the age of 25 years. This can be explained with shorter amplitudes of movement on the rings in relation to other disciplines, which means that the body of gymnast is exposed to another type of stress and physiological damage compared to the exposure on other apparatus. Specialists on rings have a longer competitive career and higher amount of won medals: OG, 1960 Rome Albert Azaryan 31.56 years (URS), 1936 Berlin Leon Štukelj 37.71 years (YUG), 2004 Athens Jury Chechi 34.86 (ITA), WC 2002 Debrecen Szilveszter Csollány 32.71 years (HUN), 2009 London Yordan Yovtchev 36.65 years (BUL), 1909 Luxembourg Frantisek Erben 34.70 years (BOH), etc...

MAG and WAG gymnasts on floor expose their body to extremely body and training load. Probably for this reason, it is not surprising that gymnasts on the floor

achieve their best results, on average, at the OG and WC at the age of 23 years (male) and 19 (female). Nunomura (2002) reported that each apparatus presents their unique characteristics. Moreover, in recent years, complexity increased in their implementation and motor demand, the fact that determined the increase in daily training hours (Nunomura, 2002, Caine, 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), flexibility, 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. This is one of the reasons short sports career at the floor on the top level.

Due to the relevance of the sample, the data obtained in this research can serve as the orientation values in guiding and shaping gymnasts in specialization to the particular apparatus, or all-around. In addition, data on the age will serve coaches in the process of planning the training and timing sports form, that is, the expectations of maximum results, given the age of their gymnasts. All top gymnasts are very similar, but some minor differences are registered Karacsony and Čuk (2005). The average age of those competitors who take first place by disciplines is registered and by large competitions which was not the case in the former literature. Obtained

results showed some, statistically, significant differences and to similar data for the two directions for giving points came (Možnik, Hraski, & Hraski, 2013).

With the changing appearance vault and its specification since WC 2001 WAG, there is a possibility for gymnast specialists on that apparatus to remain active as competitors for a long period of time. It is no coincidence that the oldest contestants in the discipline are women. Some of the competitors are: OG - 1952 Helsinki Ekaterina Kalinchuk 29.65 years (URS), 2008 Beijing Oksana Chusovitina 33.16 years (GER), 1956 Melbourne Olga Lemhényi-Tass 27.67 years (HUN), WC - 1950 Basel Helena Rakoczy 28.58 years (POL), 2011 Tokyo Oksana Chusovitina 36.33 years (GER), 2006 Aarhus Oksana Chusovitina 31.34 years (GER), etc.

We know that there are probably many intersecting factors moving the ages upwards or downwards and therefore we would mention most evident: training loads, increased number of competitions, changing number participants per events, sponsorship deals and rewards for medals. Results on changes in age, should contribute to a better overview and planning of the prosperity of individual gymnasts in order to ensure the best prognostics of their top achievements in specific disciplines.

CONCLUSION

According to the results presented and discussed herein, the following conclusions are:

- in the last 15 years there has been a linear increase in the age structure of participants in MAG and WAG at the WC 2003 - 2015.

- at OG there have been significant age change at WAG between 2004 and 2016.

- at OG between 2004 and 2016 individual men age rose, but non significantly; similar is valid also for members of teams at OG.

- changes in the General Rules and Code of Points by FIG have significantly influenced age rise compared to the previous Olympic cycles.

- male and female gymnasts ended their careers earlier in the past, while today we have some athletes in professional gymnastics who are over 35 years of age.

- as it can be noted, in the past, there was a noticeable downward trend in age of both male and female participants of the OG. In the upcoming period, we do expect that (with apparatus specialization) the age will be slightly higher.

In future studies, it would be preferable to analyze whether these increases in the age trend, in any way, relate also to the medalists of the OG and WC. Future studies should conduct the analysis between the medalists and non-medalists in gymnastics and make differentiations according to the disciplines of both genders.

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