GENDER DIFFERENCES IN CONSECUTIVE PARTICIPATION IN ARTISTIC GYMNASTICS AT THE OLYMPIC GAMES FROM 1996 TO 2016

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Original article

Abstract

The main goal of a gymnast's career is participation in the Olympic Games (OG) at least once. Survey results determined a significant difference between genders in the number of gymnasts who competed in only one OG (277 males and 408 females); also, between those who consecutively participated in two OG (104 males and 70 females), three OG (28 males and 11 females), and four OG (six males and zero females). There were no gender differences found in the number of those who consecutively participated in five OG (one male and one female) and six OG (zero males and one female). For both genders, for consecutive participants of three and more OG longevity of high-quality performance, seen through their rank in different finals, was presented showing how it is not endangered with their above average age. The obtained results should be the encouragement for the coaches to plan quality training for more than one Olympic cycle during which the constant increase in the quality of the performance, for both genders, can and should be expected.

Keywords: *average age, gymnasts, male female.*

INTRODUCTION

Participation in the Olympic Games (OG) is the most common dream of a majority of gymnasts of both genders, particularly because a large number of dropout factors that have been present since the sport's beginnings. While participation in the OG is considered a significant achievement, consecutive participation has been consider to be even a greater one.

The competition events of male and female artistic gymnastics are reportedly designed to emphasize the gender's natural qualities, such as the flexibility and gracefulness in female gymnasts (Kinnick, 1998) and the endurance and strength in male gymnasts. The different genders thus work to express these different qualities, whereas female gymnasts focus on exercises that develop their legs and the ability to flip and twist, while male gymnasts focus on the development of extreme strength and power in the upper body.

In order to succeed in gymnastics, children of both genders need to have sports talent, show dedication and persistence in

training, regardless of the size and severity of factors that influence their career.

There is no single definition for a sports talent**.** Generally**,** the term talent refers to an aptitude or a special gift of an above-average ability in a certain area. In sports, a talent generally refers to above-average abilities in the area of motor actions, and to the person possessing these abilities (Haag & Haag, 2003). However, a talent does not largely explain performance differences among people, and it does not lead to improvements in performance or to the attainment of expertise; high-quality practice - deliberate practice - does it (Ericsson, 2007, 2008; Ericsson, Krampe, & Teschromer, 1993).

The same factors have a different impact on male and female gymnasts. The following results and conclusions (of previous studies) show a complexity of male and female gymnasts career path, and consequently the "amount" of achievement of a single and (even more) of a consecutive participation at the OG.

Genders, in artistic gymnastics, differ in duration and the amount of deliberate practice spent on the path of achieving highest levels. Arkaev and Suchilin (2004) and Martindale, Collins, and Abraham (2007) state that it takes at least 8-10 years to reach top artistic gymnastics ability in girls and 10-12 years in boys. Malina et al. (2013) analyzed training loads and sequencing of training activities used in the past 30-40 years, during the period of reaching top levels, and concluded how they were highly variable among individuals. Furthermore, the authors indicated that training variability and lack of information related to gymnastics performance limited comparisons and conclusions about the necessary amount of deliberate practice required for attaining superior levels of performance in artistic gymnastics.

Gender training variability partly arises from different initial hormonal status, a timing of maturation and changes associated with achieving maturity. Namely, although gymnasts of both sexes typically have short statures, later maturation, and a slower rate of growth than the normal population (Malina, 2014), maturation experience is very different. Both genders gymnasts delayed puberty is probably: 1) a result of long hours of training (Georgopoulos et al., 2002; Caine, Bass, and Daly, 2003; Theodoropoulou et al., 2005) and 2) a result of selecting short, normal, late-maturing individuals for participation in gymnastics (Malina et al., 2013). Female gymnasts, even as children, have enough estrogen and ability to develop muscles, and their training from the beginning mostly consists of learning all required skills. In puberty, all female gymnasts achieve peak height velocity (PHV), regardless of their chronological age. The year before, during and the year after PHV, linear growth is rapid and can be as much as three inches at once (Malina & Bouchard, 1991). Rapid growth, together with increased levels of additional hormones, potentially affect female gymnasts in several ways: 1) rapid changes that occur in body structure can make consistent performance of even basic gymnastic elements difficult; in particular expansion of the hips that influence on the lowering of the centre of gravity; 2) body size increase may contrast with the ideal body type in women's artistic gymnastics (WAG): feminine, youthful, cute, and superhuman power in tiny 'pixie-like' bodies (Barker-Ruchti, 2009; Cohen, 2013; Ryan, 1995; Weber & Barker-Ruchti, 2012). For female gymnasts, main increase in strength occurs during a few months following or even just before PHV (Blimke, Roache, Hay, & Bar-Or, 1988). Between 12 and 15 years of age, muscle strength in a female gymnast only reaches 60% of the adult strength (Portmann, 1993).

Puberty affects male gymnasts in several ways that are different from female gymnasts. During pubertal stage male gymnasts also experience PHV. However, peak velocity for leg length occurs earlier than PHV while peak velocity for sitting height or trunk length, skeleton breadths and circumferences of the trunk, and upper extremities occurs after PHV. The capacity for strength increases rapidly with male

gymnasts' sexual maturation (Portmann, 1993), but it is also dependent on the time of PHV. In general, 70% of boys reach peak strength development velocity between 0.5-1.5 years after PHV (Malina & Bouchard, 1991). In the arm muscle, peak velocity occurs about 3 to 4 months after PHV. Accordingly, intensive, rigorous training male gymnasts typically experience during maturation growth spurts (not before 14 or 15) when boys experience increased testosterone levels and significant gains in muscle mass and muscular strength (Malina, Bouchard, & Bar-Or, 2004).

Compared to female gymnasts, later intensive training of male gymnasts effects later participation at competitions, giving to male gymnasts more time to prepare for competition with advanced levels of training. As a result, there is a general assumption that male gymnasts' careers last longer than female gymnasts' careers. Generally, once adolescent boys begin puberty, their testosterone production increases and is markedly higher than in girls; boys will quickly become more muscular and stronger (Borms, 1986). However, independently from differences in growth and increase in strength, in puberty fluctuating skill characteristics and "weak" performances can be expected for both genders.

In post pubertal stage males gymnasts growth continue (on the average 8 more years) while females gymnasts growth may continue after PHV. In this stage both genders reach maturity. Following puberty, strength continues to increase, right into the third decade of life (Dworetzky, 1990; Malina & Bouchard, 1991). In post pubertal stage modern mature female gymnasts look older, more muscular, and potentially larger (Kerr, Barker-Ruchti, Schubring, Cervin, & Nunomura, 2015) and it is in contrast with the WAG preference of young and small gymnasts. Very often pressure to have 'pixie-like' bodies put female gymnasts at risk for eating disorders (Kerr, Berman, & De Souza, 2006).

Another factor that significantly influences both genders training is the Code of Points (CoP): a collection of rules and requirements produced by the Fédération Internationale de Gymnastique (FIG) for Women Artistic Gymnastics (WAG) and Men Artistic Gymnastics (MAG); updated every four years following the OG. For both genders, the CoP requirements change two to three times during the period of initial training to Olympic level training. Its changing require making decisions on what gymnasts should be learning at a given time and how they should learn it in order to be successful after 6–8 years of training when it is time to compete (Donti, Donti, & Theodorakou, 2014).

In the period analyzed in this study, both genders experienced: 1) exclusion of the compulsory routines from the official competitions after 1996 OG; 2) exercising under "new" scoring system (FIG, 2006); 3) execution and appearing of new elements of E-value difficulty category (WAG CoP 1997-2000); F-value difficulty category (MAG CoP 1997-2000; WAG CoP 2001-2004); G-value difficulty category (WAG CoP 2005-2008; MAG CoP 2009-2012); H-value difficulty category (WAG CoP 2013-2016); 4) the prohibition of the repetition of an element (Donti et al., 2014; Kunčić, 2014).

Change in CoP, that probably have influenced male and female gymnasts' careers is a change of minimum senior competition age (chronological age needed for participation in senior competitions sanctioned by the FIG). This change: 1) was initiated by concerns from medical researchers who determined that intensive training at young ages was causing a range of physical and psychological problems for WAG gymnasts (FIMS/WHO, 1998); 2) was based on the results of some studies which have determined that, due to intensive training at young age, female gymnasts experience stunted growth, bone deformity, and a delayed onset of menarche (Cassas & Cassettari-Wayhs, 2006; Caine, Lewis, O'Connor, Howe, & Bass, 2001; Daly, Bass, & Finch, 2001; Dresler, 1997; Lindholm, Hagenfeldt, & Hagman, 1995; Tofler, Stryer, Micheli, & Herman, 1996);

3) was based on declined mean ages, heights, and weights of world class female artistic gymnasts declined from the mid-1960s through the 1980s (Barker-Ruchti, 2009; Claessens, Lefevre, Beunen, & Malina, 2006; Kerr et al., 2006; Malina, 1994; Ryan, 1995); 4) was made with the aim to protect the musculoskeletal development of young competitors, to lengthen their careers, to prevent burnout, to help reduce injuries, and to redirect the image of the sport positively for the public, spectators, and media (Eagleman, Rodenberg, & Lee, 2014). Although the change was mostly based on the results determined on female gymnasts, during the last three decades the FIG gradually increased minimum age requirements for both genders in artistic gymnastics. Prior to 1981, the minimum required age was 14 (gymnasts had to turn 14 by the start of the OG to be eligible). In 1981, the minimum required age was increased to 15 years of age (gymnasts had to turn 15 in the calendar year in order to compete in senior-level events). In 1997, the minimum required age changed again. Both female and male gymnasts older than 16 could participate in World Championships. However, female gymnasts who turned 16 and male gymnasts who turned 18 in the current year could participate in the OG but only as members of national teams.

Factor or a fact that is unavoidable and plays a role in the artistic gymnastics in both genders represents an extreme selection (Pion, Lenoir, Vandorpe, & Segers, 2015). In the USA, among 9 and 10 level gymnasts, only 79 out of 4.932 women (1.6%) and 136 out of 1.418 men (9.6%) were categorized as elites (USA Gymnastics, 2009). Crane and Temple (2015) analyzed through systematical review factors associated with dropout from organized sports among children and adolescents and identified five major reasons: lack of enjoyment, perceptions of competence, social pressures, competing priorities, and physical factors (maturation and injuries). Claessens and Lefevre (1998), on a sample of young competitive female gymnasts (10.5 years±2.6 years), determined that 'surviving' female competitive gymnasts were smaller with a lower body weight, a lower value of subcutaneous fat, narrower hips, and broader shoulders than their counterparts. The decision to end a career might be the outcome of severe physical and mental exhaustion in older gymnasts (18-22 years), resulting from heavy training at an early age (Koukouris, 2005). However, the available literature does not allow conclusions on the question whether individuals drop out by their choice or are selectively excluded.

Based on all aforementioned factors, for which authors presuppose that have the highest influence on the career of gymnasts (and all those factors that probably also exist but have not been discussed), posted problem of the study is Olympic gymnastics career of both genders: the beginning, duration and quality (seen through the rank of multiple consecutive participants in the OG). Thereat, we will not analyze characteristics of the Olympic path and the reasons for gymnasts' longevity; we will analyze only differences which arise from influence of different factors on male and female gymnasts' career. Accordingly, the specific study objectives are: 1) for each gender of non-consecutive and consecutive Olympians to determine age at each analyzed OG and differences in age within analyzed OG; also to determine differences in age between genders; 2) for each gender and between genders to determine differences in the overall number of OG participations; 3) for each gender and between genders to determine differences in the number of consecutive participants from one to another OG in the period from 1996 to 2016.

METHODS

The sample included participations of all elite senior male gymnasts (*N*=598) and female gymnasts (*N*=592) at the Competition 1 – Qualifications (C-I) in the OG held in 1996, 2000, 2004, 2008, 2012,

and 2016. However, due to the male and female gymnasts who had consecutive participation in the OG, the total sample number was lower: in total 416 male gymnasts and 491 female gymnasts have participated in the mentioned competitions. Consecutive participants of both genders were analyzed as subgroups of the total sample.

Gymnasts age was calculated from competitor's date of birth and date of C-I competitions at the certain OG using MS Excel function *YEAR*.

The variable sample is represented by an average age (AA) of all non-consecutive male and female Olympian gymnasts and all consecutive male and female Olympian gymnasts who competed in C-I competitions in the OG held in 1996, 2000, 2004, 2008, 2012, and 2016. Data was gathered from the official Olympic Games web site: https://www.olympic.org/gymnastics-artistic.

For all male and female Olympians, a total number of participations in the OG was determined. Rank of three and more consecutive male and female gymnasts Olympians was also recorded and presented with the aim of highlighting longevity of their quality.

Data analysis of AA included calculations of Means±Standard Deviations. Data were checked for univariate outliers, and normality of variables was confirmed using the Kolmogorov-Smirnov test. Two significant factors were identified: *gender* (male and female) and *OG Year* (1996, 2000, 2004, 2008, 2012, and 2016); and two-way 2×6 ANOVA analysis was performed. The significance of specific differences between the main factors and possible interaction effects were examined using the Fisher least significant difference (LSD) post hoc test. The partial eta squared (partial η^2) coefficient was used for effect size assessment. Groups of Olympians were compared according to their total number of participations at the OG, by using Fisher test for the significance of the difference between two independent proportions. The frequencies of all repeated gymnasts Olympians were determined for each analyzed OG. Results were considered significant if $p<.05$. All data analysis was performed using Statistica 13.0 software (Dell Inc., Tulsa, OK, USA).

RESULTS

The AA of all non-consecutive male Olympian gymnasts (n=277) who competed in the OG from 1996 to 2016 was from 23.78 years to 25.21 years (minimum=17.26 years; maximum=33.34 years), and the AA of all non-consecutive female Olympian gymnasts (n=408) was from 17.35 years to 20.94 years (minimum=14.35 years; maximum=39.38 years).

Data analysis revealed how at the 1996 OG no male gymnast with the minimum allowed age was determined; the youngest two male gymnasts aged from 17 to 18 years. Male gymnasts with the minimum allowed age were determined at the 2000 OG (n=5) and at the 2004 OG (n=2) while on all other analyzed OG the youngest male gymnasts were between 18 and 19 years old (at the 2008 OG: n=2; at the 2012 OG: n=4; at the 2016 OG: n=2). When from one OG all male gymnasts under the age of 19 were added, the following percentages of the youngest male gymnast on the OG have been obtained: at the 1996 OG=5%, at the 2000 OG=12%, at the 2004 OG=9%, at the 2008 OG=2%, at the 2012 OG=4%, at the 2016 OG=1%. There were no significant differences between percentages of the youngest male gymnasts from 1996 OG and 2016 OG (p= .07).

Female gymnasts with the minimum allowed age have been determined on all analyzed OG: at the 1996 OG seven gymnasts were between 14 and 15 years old (valid minimum age rule for that OG was turning 15 years in the Olympic year). At all other analyzed OG minimum age requirement was 16 years in the OG year, and the following number of the youngest female gymnasts have been determined: at the 2000 OG ten gymnast were under 16 years old (investigation of the FIG

determined that female gymnast Dong Fangxiao at those OG was 14.66 years old); at the 2004 OG 11 gymnasts were 15 to 16 years old; at the 2008 OG nine gymnasts were 15 to 16 years old; at the 2012 OG four gymnasts were 15 to 16 years old; at the 2016 OG two gymnasts were 15 to 16 years old. When, from one OG, all female gymnasts under the age of 16 were added, the following percentages of the youngest female gymnasts on the OG have been obtained: at the 1996 OG=28%, at the 2000 OG=10%, at the 2004 OG=11%, at the 2008 OG=9%, at the 2012 OG=4%, at the 2016 OG=2%. Significant differences have been determined between percentages of the youngest female gymnasts from 1996 OG and 2016 OG ($p < .001$).

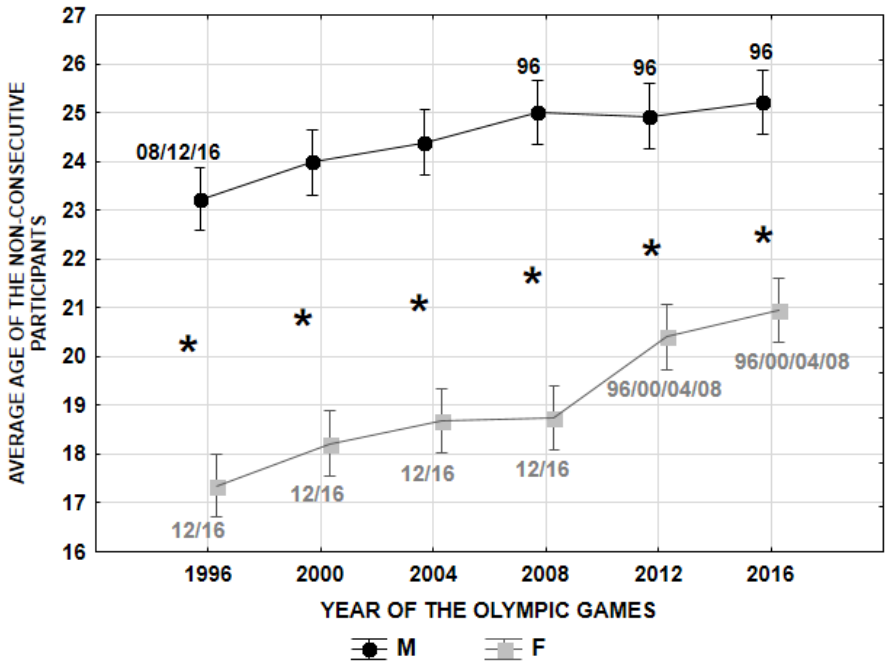

Figure 1. Average age of all male and female gymnasts (non-consecutive participants) in the OG from 1996 to 2016.

Legend. Data are presented as means ± standard deviations, M - male gymnasts, F - female gymnasts, *- significant differences between variables of average age of male and female gymnasts at certain OG, 96 - significantly different from the average age determined at OG1996, 00 - significantly different from the average age determined at OG2000, 04 - significantly different from the average age determined at OG2004, 08 - significantly different from the average age determined at OG2008, 12 - significantly different from the average age determined at OG2012, 16 - significantly different from the average age determined at OG2016.

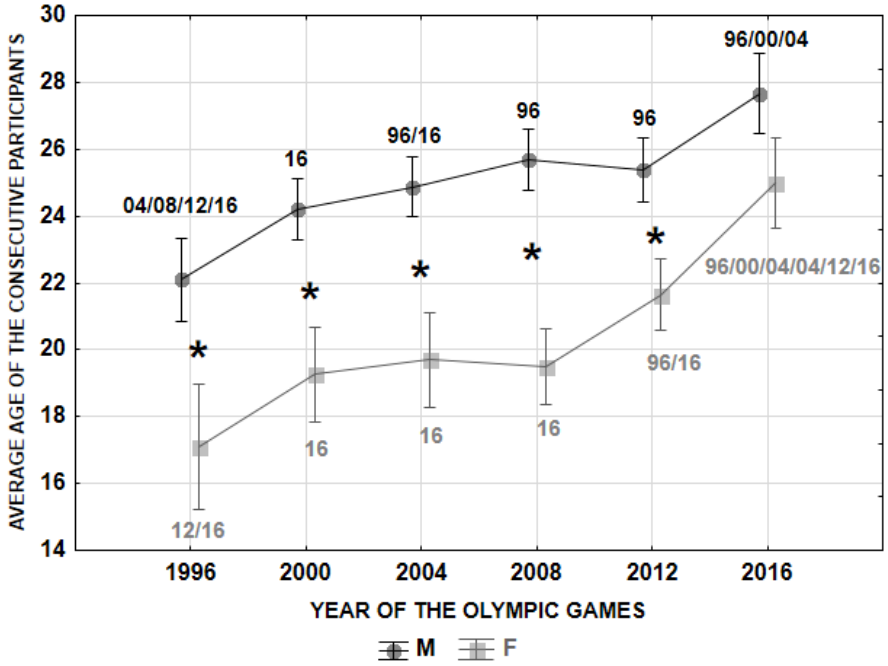

*Figure 2***.** Average age of male and female gymnasts who were consecutive participants in the OG from 1996 to 2016.

Legend. Data are presented as means ± standard deviations, M - male gymnasts, F - female gymnasts,*- significant differences between variables of average age of male and female gymnasts at certain OG, 96 - significantly different from the average age determined at OG1996, 00 - significantly different from the average age determined at OG2000, 04 - significantly different from the average age determined at OG2004, 08 - significantly different from the average age determined at OG2008, 12 - significantly different from the average age determined at OG2012, 16 - significantly different from the average age determined at OG2016.

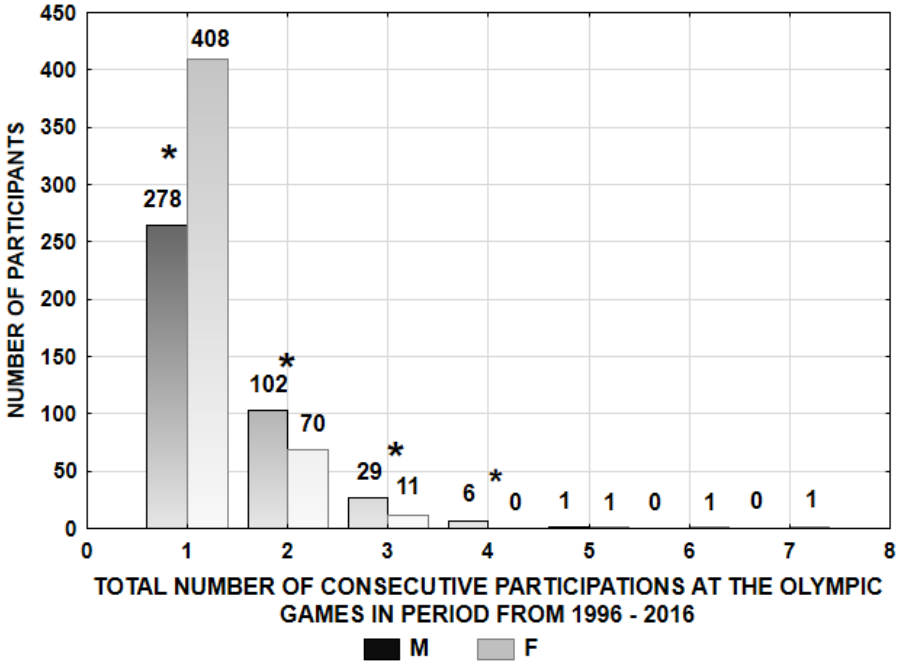

Figure 3. Overall number of participations in the OGs and differences by gender.

Legend. Data are presented as the number of competitors who participated in certain numbers of OG, M - male gymnasts, F - female gymnasts, *- significant differences between male and female gymnasts in the total number of participations in the OG.

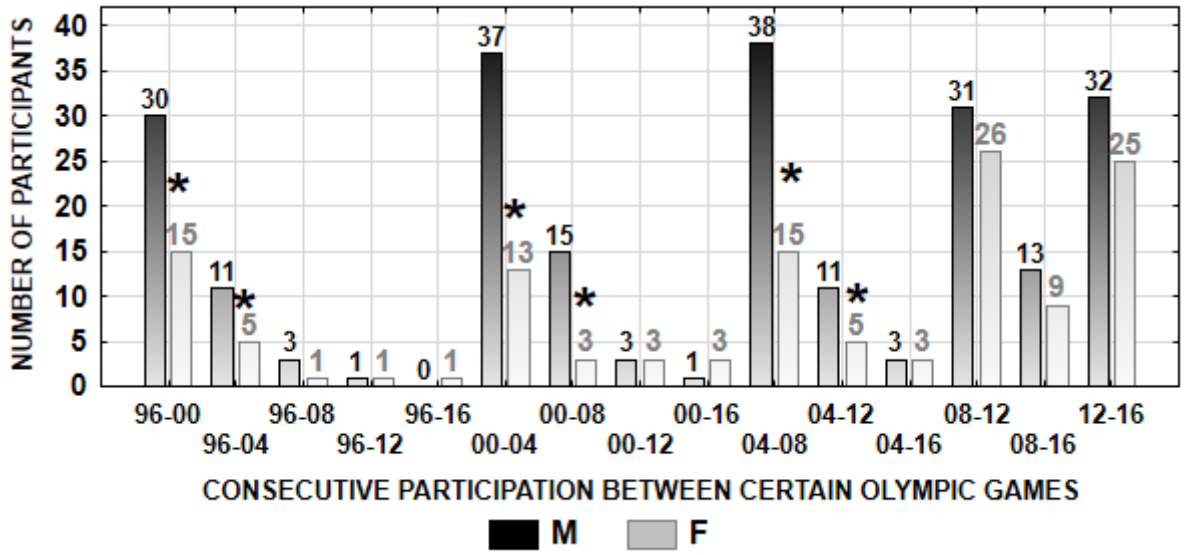

Figure 4. Number of male and female gymnasts who consecutively participated in two or more OG from 1996 to 2016.

Legend. Data are presented as the number of competitors who participated at certain numbers of OG; M - male gymnasts, F - female gymnasts;* - significant differences found between male and female gymnasts in the total number of OG participation using Fisher test for the significance of the difference between two independent proportions.

During the analyzed period the difference in the AA within male Olympian gymnasts was 2.00 years and within female Olympian gymnasts 3.58 years. A significant difference in the AA of all non-consecutive male Olympian gymnasts was determined between participants in the 1996 OG (AA=23.22 years) and participants in the 2008 OG (AA=25.00 years), 2012 OG (AA=24.92 years), and 2016 OG (AA=25.22 years). A significant difference in the AA of all non-consecutive female Olympian gymnasts was determined between participants in 1996, 2000, 2004, and 2008 OG and participants from the 2012 OG and 2016 OG.

Significant differences in AA between all non-consecutive male and female Olympian gymnasts were determined on all analyzed OG held from 1996 to 2016. Regarding the chronological age of all non-consecutive Olympians, all main factor effects and their interactions were found to be significant: *gender* ($F_{1,1164}$=774.47; p< .01; partial η^2=.40); *OG year* ($F_{5,1164}$=18.72; p< .01; partial η^2=.07); *OG year* × *gender* ($F_{5,1164}$=2.84; p= .01; partial η^2=.01).

The AA of consecutive Olympian gymnasts who participated in the OG from 1996 to 2016 ranged from 22.10 years to 27.65 years for males (minimum=16.84 years; maximum=39.47 years) and ranged from 17.10 years to 24.99 years for females (minimum=15.28 years; maximum=41.16 years). Significant differences between consecutive male and female Olympian gymnasts were not found only in the 2016 OG.

Regarding the AA of repeated Olympians, all main factor effects, and their interactions were found to be significant: *gender* ($F_{1,477}$=161.11; *p*< .01; partial η^2=.25); *OG year* ($F_{5,477}$=19.97; *p*< .01; partial η^2=.17); *OG year*×*gender* ($F_{5,477}$=2.21; *p*= .05; partial η^2=.02).

The AA of consecutive participants of both genders was higher than the AA of non-consecutive Olympian gymnasts, but it didn't have an influence on the quality and the longevity of their competitive gymnastics. Exactly the opposite: their

performances were highlighted at the OG they have participated (what will be presented for each gender within the results about the total number of participations of consecutive participants at the OG).

Of the total number of male gymnasts participations in the OG from 1996 to 2016 (*N*=598), 46% (*n*=277) participated in only one OG, 17% (*n*=104) participated in two OG, 5% (*n*=28) participated in three OG, 1% (*n*=6) participated in four OG, 0.17% (*n*=1) participated in five OG, and 0% (*n*=0) participated in six OG.

With the aim to emphasize the quality of the consecutive participants, achievements of male gymnasts who participated three and more times in the OG will be presented.

Of the 28 male gymnasts who were triple participants in the OG, 20 competed in different final competitions and 15 of them won medals in different Apparatus Finals (Kyle Shewfelt, Li Xiaopeng, Louise Smith, Kohei Uchimura, Gervasio Deferre, Alexei Nemov, Yang Wei, Marius Daniel Urzica, Marcel Nguyen, Diego Hypolito, Filip Ude, Epke Zonderland, Matteo Morandi, Valeriy Goncharov, and Igor Cassina). Three of those 15 gymnasts, at different OG, also won a total of seven medals in the most demanding finals, the All-Around Finals: Kohei Uchimura won silver at the age of 19.63 years (2008 OG), won gold at the age of 23.60 years (2012 OG), and won gold at the age of 27.63 years (2016 OG); Alexei Nemov won silver at the age of 20.09 years (1996 OG) and won gold at the age of 24.33 years (2000 OG); Yanda Wei won silver at the age of 20.63 years (2000 OG) and won gold at the age of 28.54 years (2008 OG). The five triple participants in the OG took a part in different final competitions but did not win medals.

Of six male gymnasts that participated in four consecutive OG (Alberto Busnari, Marian Dragulescu, llia Giorgadze, Fabian Hambuechen, Yann Cucherat, and Vlasios Maras), three of them (Busnari, Hambuechen, and Dragulescu) competed in the All-Around Finals but were not medalists. Two participants won a total of five medals in different Apparatus Finals (Fabian Hambuechen won bronze on the high bar in the 2008 OG, silver on the high bar in the 2012 OG, and gold on the high bar in the 2016 OG; and Marian Dragulescu won silver on the floor and vault in the 2004 OG).

In the analyzed period, only one male competitor, Iordan Iovtchev, whose age was 39.48 years in the 2012 OG, participated in five consecutive OG and won a total of four medals. Iovtchev also participated in the 1992 OG and became the first man in the history of sports with six appearances at the Summer OG; he was admitted into the International Gymnastics Hall of Fame in 2016.

The quality of performance of male participants who consecutively participated at three or more OG is indicated by the fact that, of 35 of them, 14 invented in total 17 new gymnastics elements. Two new elements were invented by Xiaopeng, Urzica, and Iovtchev; Shewfelt, Tsukahara, Deferre, Nemov, Nguyen, Hypolito, Zonderland, Morandi, Cassina, Busnari, and Dragulescu each invented one new element (Fédération Internationale de Gymnastique, 2017).

Of the total number of female gymnasts participations in the OG from 1996 to 2016 (*N*=592), 68% (*n*=408) participated in only one OG, 12% (*n*=70) participated in two OG, 2% (*n*=11) participated in three OG, 0% (*n*=0) participated in four OG, 0.17% (*n*=1) participated in five OG, and 0.17% (*n*=1) participated in six OG.

Like for male gymnasts, accomplishments of female gymnasts' participants at three and more OG will be presented to emphasize their quality.

A group of 11 female gymnasts had three appearances at the OG in the analyzed period and thus contributed to the overall increase in the AA for female Olympian gymnasts (especially in their last OG). These gymnasts included the following: Svetlana Khorkina (25.59 years in the 2004 OG); Lisa Skinner (23.51 years in the 2004 OG); Monica Bergamelli (24.23 years in the 2008 OG); Daiane dos Santos (29.40 years

in the 2012 OG); Elizabeth Tweddle (27.50 years in the 2012 OG); Vanessa Ferrari (25.84 years in the 2016 OG); Jessica Brizeida Lopez Arocha (30.56 years in the 2016 OG); Vasiliki Millousi (32.36 years in the 2016 OG); Gaelle Mys (24.74 years in the 2016 OG); Catalina Ponor (28.99 years in the 2016 OG); and Sherine Elzeiny (25.47 years in the 2016 OG). It is important to point out that, despite three appearances at the OG, in the analyzed period the career of Catalina Ponor actually lasted for four Olympic cycles (due to injury, she did not participate in the 2008 OG, which would have been her second consecutive OG, but she participated at the 2012 and 2016 OG).

In the analyzed period, there were no female gymnasts with four consecutive Olympic appearances. However, there were five consecutive appearances in the OG by Hypolito Daniele (32.02 years in the 2016 OG), and six consecutive participations at the OG by Oksana Chusovitina (41.16 years in the 2016 OG). Chusovitina's number of participations and her comparatively older age make her an outlier not only in artistic gymnastics but in most elite sports. Her participation at the Summer OG in Rio made her the oldest female gymnast in Olympic history.

Mature look and age above the AA of other female Olympian gymnasts did not prevent consecutive participants to achieve top results, even on their consecutive OG: Khorkina won gold in her second OG (2000) on the uneven bars and won silver in the All-Around Finals and floor routine; she also won silver in the All-Around Finals in her third OG (2004); Skinner won eighth place in the All-Around Finals and eighth place on the floor during her second OG (2000); Dos Santos won sixth place on the floor during her second OG (2008); Tweddle finished fourth in her second OG (2008) and won bronze on the uneven bars in her third OG (2012); Ferrari was eighth in the All-Around Finals and fourth on the floor during her second OG (2012), and was 16th in the All-Around Finals and fourth on the floor during her third OG (2012); Lopez Arocha was 18th in the All-Around Finals during her second OG (2012) and was 17th in the All-Around Finals and sixth on the uneven bars during her third OG (2016); Ponor won silver on the floor and was fourth on the balance beam during her second OG (2012), and was seventh on the balance beam during her third OG (2016).

Groups of male and female gymnasts Olympians were compared according to their total number of participations at the OG, by using Fisher test for the significance of the difference between two independent proportions. Compared to the number of participants at two consecutive OG, the number of male and female gymnasts who participated in three, four, five and six OG was significantly lower. A significant difference was determined between those male and female gymnasts who consecutively participated in two (25% of total number of male and 14% of total number of female gymnasts), three (7% of total number of males and 2% of total number of female gymnasts), and four (1% of total number of male and 0% of total number of female gymnasts) OG, while there was no significant difference found in the number of male and female gymnasts who participated in five (0.2% of total number of male and of female gymnasts) and six (0% of total number of males and 0.2% of total number of female gymnasts) consecutive OG.

The largest number of consecutive Olympians (of both genders) was determined at the transition of two successive OG (1996-2000, 2000-2004, 2004-2008, 2008-2012, and 2012-2016), while a smaller number of consecutive Olympians was determined at the transition of non-consecutive OG. In males, the number of consecutive participants in the OG was from 30 (1996-2000 OG) to 38 (2004-2008 OG) and generally represented between 30% and 38% of the total number of male gymnasts who participated in the upcoming OG. In females, the number of consecutive participants in the OG ranged from 13 (2000-2004 OG) to 26 (2008-2012 OG) and generally represented between 8% and 27% of the total number of female

gymnasts who participated in the upcoming OG.

Significant differences between genders (of consecutive Olympian gymnasts) were determined in the number of those who consecutively participated in the OG from 1996 to 2000, from 1996 to 2004, from 2000 to 2004, from 2000 to 2008, and from 2004 to 2008.

DISCUSSION

Survey results found that the number of male gymnasts who participated at more than one OG was significantly higher than the number of female gymnasts.

The AA of all non-consecutive male Olympian gymnasts from 1996 to 2016 (expected) is in accordance with the results of Arkaev & Suchilin (2004) and Andreev (2015). Furthermore, the linear and second-order polynomial-regression increase in the AA of male and female gymnasts who had participated at the OG and at the World Championships was also determined by Atiković, Delaš Kalinski and Čuk (2017). However, determined ascending trend of AA is opposite from the downward AA trend of male Olympian gymnasts population determined in the period from 1964 OG (AA=25.6 years±2.9 years) to 1976 OG (23.7 years±5.5 years; Arkaev & Suchilin, 2004); also from the decline trend of AA of Olympic medal winners (determined by Andreev (2015)). Reason for male gymnasts ascending trend of the AA partly probably need to search in ever-increasing technical difficulty demands that arise from changes in CoPs every Olympiad. Namely, after 1996 OG and exclusion of the compulsory routines from the official competitions, MAG witnessed to the appearance of not only new elements but also of new difficulty categories in the CoP. With the aim of fulfilling the FIG demands of each new CoP, male gymnasts training are mostly based on the repetition of strength-related skills, because of what is, almost constantly, characterized as specific strength conditioning training (Jemni, Sands, Friemel, Stone, & Cooke, 2006). Such trainings are not being implemented just lately; for the last 4 decades male gymnastics training has been characterized with nearly constant maximal oxygen uptake values and the increasing peak power (Jemni, Friemel, Sands, & Mikesky, 2001). Only those male gymnasts who possess high levels of speed and strength are able to perform high difficulty values elements of modern MAG, what mostly leads to a higher competitive score (Jemni et al., 2006). Becuase achieving of such extreme levels of strength (obviously) need a longer time, increase of male gymnasts AA is the logical result.

Although successive increases in AA were established between 1996 OG and 2016 OG analysis of the AA trend of all non-consecutive male Olympians did not determine a significant difference between two successive OG. A significant difference was determined between the AA from the 1996 OG and the AA from the 2008 OG, 2012 OG, and 2016 OG. This result is somewhat unexpected since a significant difference in the AA appeared 11 years after the 1997 increase in the minimum age. However, since the AA of non-consecutive male Olympians was significantly higher than the minimum age requirements (even in the 1996 OG, the AA was 23.22 years), then it is logical that the 'normative' increase determined in the AA after 1997 contributed to the determination of significant differences in the AA after a certain (longer) period of time. Because, in MAG, a significant difference has not been determined between percentages of the youngest male gymnasts before and after 1997 rule (male gymnasts have to turn 18 years to participate at OG) the influence of the rule (on the percentage of the youngest male Olympian gymnasts) is unknown. Also, it remains unknown whether the AA of male Olympian gymnasts would be increased without changes in the minimum age requirements. It is possible that AA might have changed regardless changes to the minimum age requirements, all due to increased scientific knowledge about biological maturity and the longevity of

development of the maximum power needed for the performance of the most demanding elements of MAG (Malina et al., 2004).

Like for male gymnasts, the study determined the ascending trend of AA of all non-consecutive female Olympian gymnasts which is opposite from a descending trend of AA determined from the mid-60s through the 1980s (from 1964 OG (AA=22.2 years±2.8 years) to 1976 OG (AA=18.3±5.5 years; Arkaev & Suchilin, 2004). Authors suspect that the increase of AA, in the analyzed period, is partly a consequence of: 1) decreased percentage of the female gymnasts with the minimum allowed age for participation in the OG (from 28% at the OG1996 to 2% at the OG2016); 2) increased percentage of female gymnasts older than 20 years (from 11% that have been determined at the 1996 OG over 18% at the 2000 OG, 21% at the 2004 OG, 23% at the 2008 OG, 48% at the 2012 OG, right until 51% of 20+ years old gymnasts that have been determined at the 2016 OG); all probably related to the increase of the minimum age. Confirmation for the same arises from the significant difference that has been determined among percentages of the youngest female gymnasts from the time before 1997 rule, and ones from the time after this rule (rule from 1997 determined that female gymnasts have to turn 16 years to participate at OG). Since this is a sample of the youngest female gymnasts, who in career participated only once in the OG, and since the problem and increasing of the minimum age was initiated by concerns from medical researchers determined in WAG on similar sample (FIMS/WHO, 1998), obtained results confirm the effectiveness of the increase of the minimum age for the female gymnasts who tend to participate in the OG. However, further investigation is needed to determine whether minimum age requirements have had other effects, including effects on the musculoskeletal development of young competitors, on injury reduction, and on positively changing the image of the sport for the public, fans, and media (Eagleman et al., 2014).

Similar to male gymnasts, AA of non-consecutive female gymnasts didn't show a significant increase immediately after the 1997 rule. However, differently than in male gymnasts, an increase was found between two consecutive OG: 2008 OG (AA=18.74 years) and 2012 OG (AA=20.40 years). This result is likely due to the number of female gymnasts who had consecutive appearances from 2008 OG to the 2012 OG (n=26), which is almost doubled compared to the number of female gymnasts who had participations at two successive OG in the earlier periods (n=15 for 1996-2000 OG; n=13 for 2000-2004 OG; n=15 for 2004-2008 OG).

Similar to AA of male gymnasts, and expected, due to the previous results about percentages of the youngest and the 20+ years old female gymnasts, the AA of non-consecutive female gymnasts was also found to be significantly different from the normative minimum age requirement for all analyzed OG.

Due to multiple participations at the OG, higher AA values of consecutive Olympian gymnast of both genders (AA_{MALES}=24.99 and $AA_{FEMALES}$=20.66) compared to AA of non-consecutive Olympian gymnasts (AA_{MALES}=23.78 and $AA_{FEMALES}$=18.34) are logical and expected result. Although the trend of AA, in the analyzed period, for both genders was upward, and although the significant differences in AA between genders have been determined on almost all analyzed OG, the range of the AA increase for female gymnasts (AA_{FEMALE} increase ranged from 0.42 years to 3.34 years) was bigger than for male gymnast (AA_{MALE} increase ranged from 0.68 years to 2.26 years). The same suggests approaching of the AA of consecutive female gymnasts towards AA of consecutive male gymnasts, and accordingly, possible equality in the longevity of theirs careers. However, further studies, on the Olympian gymnasts of both genders, on the upcoming OG, are needed to be conducted to confirm this assumption.

Results of consecutive gymnasts of both genders, who participated at three and

more OG, clearly show the positive influence of maturity on the performances of the high-class gymnasts. For male gymnasts who start with intensive training later than female gymnasts, and whose maturity is "welcomed", because enable them to develop extreme levels of strength needed to fulfill CoP requirements, longevity associated with the continuous advancement in the performance is expected and in accordance with Andreev (2015). The author determined that AA of male Olympic medal winners (from 1960 to 2012) was approximately 23.9 years; 23-year-olds won 50 medals, 24-year-olds won 41 medals, and 22-year-olds won 35 medals. With this data, the author characterized the ideal age for achieving success in MAG in the OG (Andreev, 2015). Opposite to that, for the highest results of consecutive female gymnasts may be assumed that are somewhat surprising, especially if are seen through the concept of artistic gymnastics that prefer the tiny 'pixie-like' body that demonstrates femininity, youthfulness, cuteness, and superhuman power (Barker-Ruchti, 2009; Chisholm, 1999; Weber & Barker-Ruchti, 2012). However, independently from being characterized as older, more muscular, and potentially larger (Kerr et al., 2015), those consecutive female gymnasts obviously possess some other characteristics that enable them to be within best modern female gymnasts.

As one of the key factors that lead to improvements in performance and to the attainment of expertise, the training of 'older' female gymnasts has been a subject of research. According to Kerr et al. (2015), in many cases older female gymnasts trained significantly less than when they were younger or less than their younger teammates, due to increased knowledge, gained through experience; also to reduce demands on the body, due to a strong belief (held by many gymnasts) that an older body cannot complete as many repetitions as a younger body. According to the same study, the area where older gymnasts had potentially higher forms of capital was in their ability to express themselves artistically (Kerr et al., 2015). The importance of artistry in women's gymnastics has been a concern of the FIG and was incorporated in its execution score since 2009 (WAG FIG, 2009-2012).

Results of consecutive female gymnasts, on their consecutive OG, further confirm that female gymnasts can have prolonged careers and skills development after the age of 16, and that it is possible to have top-level achievements after the age of 20 (Zurc, 2017).

Atiković, Kalinski, Petković and Čuk (2017) examined the AA medalist and non-medalist teams, consisting of consecutive and non-consecutive Olympians, that participated at the Olympic Games between 1996 and 2016, and determined there were no significant differences in the chronological age between the medalist and non-medalist teams, that participated at the Olympic Games between 1996 and 2016 with the exception of OG2000 and OG2012. On the other hand, the significant differences were not determined between teams of female gymnasts either (Atiković, Delaš Kalinski, Petković, & Čuk, 2017).

Based on presented accomplishments (ranks) of consecutive gymnasts of both genders, authors support the conclusion that, despite early identification of talent, excellence in sports is not a product of a standard set of factors; it can be achieved in individual or unique ways through different combinations of factors (this effect has been termed the "compensation phenomenon" (Vaeyens, Lenoir, Williams, & Philippaerts, 2008)). The gymnasts with the very best profiles on most performance-related parameters (the best compensators) are those that might have the highest chances of progressing from their training efforts (Pion et al., 2015). However, regardless of initial individual characteristics, "unless there is a long and intensive process of encouragement, nurturance, education, and training, individuals will not attain extreme levels of capability in specific fields" (Bloom, 1985).

CONCLUSION

Changes in the CoP by the FIG, through time, have significantly increased the age and (probably) prolonged the careers of male and female gymnasts. However, due to differences in the development of gymnasts' careers, the number of female Olympian gymnasts who have participated in two, three, and four consecutive OG was significantly lower than the number of male Olympian gymnasts. When all consecutive gymnasts are analyzed together, non-significant difference in AA between male and female gymnasts determined at last OG (2016 OG) can lead to the assumption that the lengths of current and future female gymnasts' careers will be equal to the length of male gymnast career. Until this assumption be confirmed, based on the majority of obtained results, remains to be concluded that the careers of female gymnasts are significantly shorter than careers of male gymnasts. This conclusion confirms previous empirical findings in this area. From several factors that have an influence on the gymnasts' career, one factor (change of the rule about minimum age requirements) was analyzed. Obtained results were different for genders highlighting the following: the change of minimum age influenced on the percentage of the youngest Olympian female gymnasts, but didn't have the influence on the percentage of the youngest Olympian male gymnasts.

Rank of the best consecutive male and especially consecutive female gymnasts is not dependable or endangered by their age; their quality of performance is the main factor of their success.

Obtained results of increased AA, present an extension of the duration of the available training years-favorable condition for all the parameters affecting gymnasts' well-being. Together with the increased number of older gymnasts and consecutive gymnasts of both genders should encourage coaches to redefine athletes' technical skill development (according to international standards) and to plan quality training for more than one Olympic cycle. We assume that those training changes will help to protect gymnast health, to reduce dropout and to prolong gymnast career at the highest international levels. However, it remains to be explored in further studies.

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