Original Article

Historical analysis of the chronological age trend of the participants of men's artistic gymnastics who have won medals in the period between 1896 and 2016

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Abstract

The OG and 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 men's artistic gymnastics who have won medals in the period between 1896 and 2016 has been made. The examinees were gymnasts who had won medals at the following competitions: Olympic Games (OG) from 1896 to 2016 (n=1177) and World Championships (WC) from 1903 to 2015 (n=1651). 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. Changes in the General Rules and Code of Points by the Fédération Internationale de Gymnastique after 1997 years the trend is a significant change only on WC but not on OG. 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.

Keywords: medals, history, t-test, men's artistic gymnastics, trend

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, Athens (GRE). The first ever gymnastics World Championships (WC) took place in 1903, Antwerp (BEL). The OG and WC represent the crown of each athlete's career, so it is the same with gymnasts. Training required for the OG and WC, as the most important event in the career of every athlete, consist of child's entire perennial preparation. That is why you can safely assert that the best competitors come to these competitions. The sport of gymnastics is continually evolving. 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, 2013, 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 per week through the year (Caine et al., 1989), while contemporary elite level gymnasts train 20–30 h per 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.

Available data for this research focus on ages history top level male gymnast. Autor Škerlj (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 (2000) 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 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, 2001, 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 and Suchilin (2004).

In 2000, a World Cup in male Gymnastics was organised in Ljubljana (Slovenia). The meeting was attended by 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 et 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 athletes at OG2012 (n=10881). Artistic gymnastics 2012 (average age female 18.52 yrs, male 22.64 yrs (The Guardian, 2012). The average heights of the Olympic all-round gymnastics champions has generally decreased in the data shown from 1956 until 2012.

Thus, the current study aims to 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.

Methods

Subjects

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

Table 1. Olympic Games (OG) from 1896 to 2016 (n=1177)

Events for men	Abbreviations	Gold	Silver	Bronze	SUM	Missing in %
All-around individual (AAI)	OGAAI	26	28,-1	28	83,-1	-1,1
Team (TEAM)	OGTEAM	224	211,-15	216,-4	670,-19	-2,7
Floor (FX)	OGFX	19	24	18	61	0
Pommel horse (PH)	OGPH	31,-1	19	20	70,-1	-1,4
Rings (RI)	OGRI	24	22	26	72	0
Vault (VT)	OGVT	25	24	25	74	0
Paralell bars (PB)	OGPB	23	23	26	72	0
High bar (HB)	OGHB	30	22	23	75	0

Table 2. World Championships (WC) from 1903 to 2015 (n=1651)

Events for men	Abbreviations	Gold	Silver	Bronze	SUM	Missing in %
All-around individual (AAI)	WCAAI	43	38,-3	41,-3	128,-6	-4,4
Team (TEAM)	WCTEAM	212,-33	186,-55	187,-56	729,-144	-19,7
Floor (FX)	WCFX	37	37	37	111	0
Pommel horse (PH)	WCPH	46,-2	44,-5	35,-6	138,-13	-8,6
Rings (RI)	WCRI	51,-3	38,-3	43,-2	140,-8	-5,4
Vault (VT)	WCVT	37	33,-2	34,-2	108,-4	-3,5
Paralell bars (PB)	WCPB	54,-1	48,-1	42,-4	149,-6	-4,0
High bar (HB)	WCHB	51	48,-3	41,-5	148,-8	-5,1

Data collection

All the data concerning the medallists were gathered at: Wikipedia Olympic Games from 1896 to 2016 [https://en.wikipedia.org/wiki/List_of_Olympic_medalists_in_gymnastics_\(men\)](https://en.wikipedia.org/wiki/List_of_Olympic_medalists_in_gymnastics_(men)), Wikipedia World Championships from 1903 to 2015 https://en.wikipedia.org/wiki/World_Artistic_Gymnastics_Championships, 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") (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 (mean and standard deviation) are presented for individual apparatuses, team and competition years in (Table 5). In order to check for any deviation from normality, a number of methods can be used. One method is to use skewness and kurtosis. 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 OG and WC.

Results

The youngest medallists at the OG were: Petros Persakis (GRE) 17.28 years of age - 1896 Athens, Einari Teräsvirta (FIN) 17.63 - 1932 Los Angeles, Yukio Iketani (JPN) 17.99 - 1988 Seul. The oldest medallists at the OG were: Masao Takemoto (JPN) 40.93 - 1960 Rome, Heikki Savolainen (FIN) 40.87 - 1948 London, Leon Štukelj (YUG) 37.71 - 1936 Berlin. The youngest team to win a medal at the OG was China (CHN) 20.35 - 1992 Barcelona. The oldest team to win a medal at the OG was Finland (FIN) 31.75 - 1952 Helsinki.

The youngest medallists at the WC were: Li Xiaopeng (CHN) 16.11 years of age - 1997 Lausanne, Feng Jing (CHN) 16.79 - 2001 Ghent, Xiao Qin (CHN) 16.80 - 2001 Ghent. The oldest medallists at the WC were: Masao Takemoto (JPN) 38.79 - 1958 Moscow, Josip Primožić (YUG) 38.42 - 1938 Prague, Yordan Yovtchev (BUL) 36.65 - 2009 London. The youngest team to win a medal at the WC was China (CHN) 17.61 - 1997 Lausanne, the oldest team to win a medal at the WC was (TCH) 31.49 - 1938 Prague.

In (Table 3) the central and dispersal result parameters from the OG have the highest result span amounting on OGHB 23.30 years of age and the lowest on OGPB 15.71 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 on OGRI 17.28 years of age and the highest value on OGHB 40.93 years of age. Analysing the results in arithmetical environments of all variables the highest values were recorded on RI 26.48, and the lowest on FX 24.56.

In (Table 3) the central and dispersal result parameters from the WC have the highest result span on WCFX 22.68 and the lowest on WCHB 16.42. 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 on WCFX and WCPB 16.11 and the highest value on WCFX 28.79.

Analysing the results in arithmetical environments of all variables the highest values were recorded on WCRI 25.21, and the lowest on WCFX and WCVT 38.79.

The results in (Table 3) of independent t test were significant, t test (172) = 2.05, p = .04, d = 1.31, r = .15, indicating that there are significant differences between OGPB (M = 25.56, SD = 3.71, n = 62) and the scores at the WCPH (M = 24.34, SD = 3.78, n = 112). The effect size, r was very small. The results of independent t test were significant, t test (182) = 2.30, p = .02, d = .34, r = .16, indicating that there are significant differences between OGRI (M = 26.48, SD = 3.84, n = 69) and the scores at the WCRI (M = 25.21, SD = 3.50, n = 182). The effect size, r was very small. The results of independent t test were significant, t test (182) = 2.88, p = .00, d = .42, r = .20, indicating that there are significant differences between OGPB (M = 26.35, SD = 3.79, n = 71) and the scores at the WCPB (M = 24.66, SD = 3.92, n = 1113). The effect size, r was small.

The central and dispersal result parameters from the OG have the highest result span amounting on OGHB2 20.64 years of age and the lowest on OGPB2 10.62 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 on OGRI3 17.28 and highest on OGHB2 40.93. Analysing the results in arithmetical environments of all variables the highest values were recorded on OGRI2 27.64, and the lowest on OGFX1 23.31.

The central and dispersal result parameters from the WC have the highest result span amounting on WCFX1 21.68 years of age and the lowest on WCVT1 12.58 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 on WCFX3 and WCPB2 16.11 while the highest is on WCFX1 and WCVT2 38.79. Analysing the results in arithmetical environments of all variables the highest values were recorded on WCRI2 26.23, and the lowest on WCFX3 23.02. The results in (Table 3) of independent t test were significant, t test (67) = 1.99, p = .05, d = .48, r = .23, indicating that there significant difference between OGAA1 (M = 26.23, SD = 3.60, n = 27) and the scores at the WCAA1 (M = 24.35, SD = 3.94, n = 42). The effect size, r was small. The results of independent t test were significant, t test (66) = 3.16, p = .00, d = .77, r = .32, indicating that there are significant differences between OGPB1 (M = 27.00, SD = 4.10, n = 24) and the scores at the WCPB1 (M = 24.11, SD = 3.29, n = 44). The effect size, r was small.

Table 3. Descriptive Statistics and Independent Samples Test Olympic Games and World Championships in men's artistic gymnastics

Competitions	Olympic Games		World Championships		t-test for Equality of Means				
	N	Mean±SD	N	Mean±SD	t	df	P	d	r
AAI	79	25.64 (3.69)	119	24.67 (3.86)	1.75	196	0.08	0.25	0.12
FX	56	24.56 (3.88)	111	23.84 (4.02)	1.10	165	0.26	1.17	0.08
PH	62	25.56 (3.71)	112	24.34 (3.78)	2.05	172	0.04*	1.31	0.15
RI	69	26.48 (3.84)	115	25.21 (3.50)	2.30	182	0.02*	0.34	0.16
VT	69	25.55 (4.04)	98	24.47 (4.03)	1.69	165	0.09	0.26	0.13
PB	71	26.35 (3.79)	113	24.66 (3.92)	2.88	182	0.00*	0.42	0.20
HB	65	25.97 (4.37)	118	25.09 (3.78)	1.42	181	0.15	0.22	0.11
TEAM	78	25.24 (2.72)	111	24.64 (2.91)	1.43	187	0.15	0.21	0.10
AAI1	27	26.23 (3.60)	42	24.35 (3.94)	1.99	67	.05*	0.48	0.23
AAI2	26	25.63 (4.12)	38	24.36 (3.74)	1.28	62	.20	0.32	0.16
AAI3	26	25.03 (3.36)	39	25.33 (3.91)	-.31	63	.75	-0.08	0.04
FX1	20	23.31 (3.79)	37	24.34 (4.48)	-.87	55	.38	-0.23	0.11
FX2	20	25.90 (3.30)	37	24.15 (3.99)	1.67	55	.10	0.45	0.21
FX3	16	24.45 (4.33)	37	23.02 (3.51)	1.26	51	.21	0.3	0.17
PH1	23	25.91 (3.74)	42	24.82 (3.78)	1.11	63	.27	0.28	0.13
PH2	19	26.50 (3.50)	38	24.49 (3.98)	1.86	55	.06	0.50	0.24
PH3	15	24.84 (3.86)	32	23.53 (3.50)	.72	50	.47	0.20	0.10
RI1	24	26.12 (3.10)	43	25.29 (2.98)	1.06	65	.28	0.26	0.13
RI2	22	27.64 (4.41)	35	26.23 (4.12)	1.23	55	.22	0.33	0.16
RI3	23	25.75 (3.86)	37	24.14 (3.20)	1.74	58	.08	0.45	0.22
VT1	24	25.78 (4.55)	35	23.87 (3.58)	1.79	57	.07	0.47	0.23
VT2	22	26.19 (3.75)	32	25.41 (4.77)	.63	52	.52	0.17	0.08
VT3	23	24.69 (3.76)	31	24.17 (3.62)	.51	52	.61	0.14	0.07
PB1	24	27.00 (4.10)	44	24.11 (3.29)	3.16	66	.00*	0.77	0.32
PB2	24	25.64 (2.97)	35	25.25 (4.21)	.39	57	.69	0.10	0.05
PB3	23	26.42 (4.23)	34	24.75 (4.38)	1.43	55	.15	0.38	0.18
HB1	24	26.07 (3.45)	45	24.74 (3.77)	1.43	67	.15	0.34	0.17
HB2	20	26.36 (5.25)	40	25.79 (3.57)	.49	58	.62	0.13	0.06
HB3	21	25.50 (4.58)	33	24.74 (4.03)	.64	52	.52	0.17	0.08
TEAM1	26	25.58 (2.91)	38	24.73 (3.13)	1.10	62	.27	0.27	0.13
TEAM2	26	24.96 (2.56)	37	24.79 (3.09)	.22	61	.82	0.05	0.02
TEAM3	26	25.19 (2.75)	36	24.38 (2.54)	1.18	60	.23	0.30	0.15

* P < 0.05 The statistical significance was defined at 5%

Discussion and conclusion

If we compare the age of the MAG by disciplines, the oldest gymnasts are on the RI with an average age on (OG: $M = 26.48$, $SD = 3.85$) and on (WC: $M = 40.23$, $SD = 3.50$) years old, and the youngest in the same are contestants (OG: $FX = 23.09$, $SD = 3.88$) and (WC: $M = 7.86$, $SD = 4.02$). With the fact that static strength is required for the RI, it is obvious that for getting these motor skills a certain period of training is required, but the age of competitors is also significant, because the best results on the RI are expected only after the age of 25 years. This can be explained easier and shorter with amplitudes of movement on the RI 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 widgets, so by extension, specialists for the RI have a longer gymnastics career.

Unlike them, 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. 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 Mochigucki, 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, 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. This one of the reasons short sports career at the FX.

Gymnasts have incredible neuromuscular connections and they are also characterized by very high levels of strength, power, flexibility, and muscular endurance, combined with speed and coordination (Jemni et al, 2006). Results of the study of Jamni and colleagues showed the high peak power values, placing the gymnasts near the top levels of power athletes (Jemni et al, 2006). Special training is necessary to develop the strength and power in the athlete sufficient for correct technical performance of skills (according to Major, 1996), but there is also a need for conventional strength and power training. It is known, the most important motor ability for gymnasts is strength and power, certainly, more precisely strength and power coupled with flexibility (Major, 1996).

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 device, 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. 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. (Moznik, Hraski, and Hraski, 2013).

What can be seen from results, is the ongoing downward trend of the age of participants at the OG. Unlike the OG, on the WC, we can observe that after a change in the rules of the competition and the age limit issued by FIG, comes to a slight rising trend age of medals cup winners at major international competitions (Van Anderson, 1997). We assume that the trend in the coming years is to be growing, both for the OG and the WC because the requirements for athletes in every way are increased.

In conclusion, the increased complexity of Code of Points in terms of difficulty value and an increased number of deductions, according to need longer competitive internship to be successful. 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. Changes in the General Rules and Code of Points by FIG after 1997 years the trend is a significant change only on WC but not on OG.

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