BODY COMPOSITION PROFILE OF ELITE GROUP RHYTHMIC GYMNASTS

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Abstract

The aim of this study was to analyze the anthropometric characteristics, training experience, body composition and biological maturity of Elite group gymnasts. 84 RG group gymnasts from the 2009 and 2010 World Cup were evaluated. Body Mass Index (BMI) was calculated using standard procedures. Relative body fat (%BF), fat mass and lean body mass were estimated from skinfold thickness, and waist/hip circumferences were measured. Biological maturity was determined by the age at menarche.
An increase on the age of the gymnasts participating in high level competitions seems to affect the new body appearance profile. Gymnasts are taller and with higher body mass than in the past. BMI were at the normal range whatever the success in competition. The more successful gymnasts had lower values of %BF but still higher than what have been reported in RG studies. A relation between the body composition data and the results has been not found. The higher level gymnasts had begun activity in RG earlier, and had more years of practice, and higher training volume. All gymnasts had a late menarche. We think that the initial selection of gymnasts who had late maturate can influence their body appearance when they become adults.

Keywords: *rhythmic gymnastics groups, body composition, profile, ranking.*

INTRODUCTION

Aesthetic requirements in sports performance evaluation are usually the cause of the body composition importance. Gymnastics, ice skating and synchronized swimming can be included in this group (Lebre, 1993). On the other hand, athlete development is the result of organized physical and technical training, methodical, rigorous, and based on the sports demands and the participants morphological profile (Freitas, 2007). According to Lebre (1993) since Seoul Olympic Games in 1988, with the first place occupied by a Soviet Union gymnast and with physical characteristics very different from the Bulgarian School, the body composition and the body appearance with very low body fat became less important. Although the International Federation of Gymnastics (FIG) Rhythmic Gymnastics (RG) Code of Points (2009) does not include deductions related to the gymnasts' body composition profile, it requires that all group gymnasts should have similar body appearance. However, very few authors studied the physical characteristics and body composition of International level RG gymnasts (Berlutti et al., 2010; Colombo, 1997; Douda, Toubekis, Avloniti, & Tokmakidis, 2008; Georgopoulos et al., 1999; Georgopoulos et al., 2002; Georgopoulos et al., 2001; Klentrou & Plyley, 2003; Pineau, 1994;

Theodoropoulou et al., 2005) and most of all with no specific reference to group gymnasts.

The aim of this study was to analyse the anthropometric characteristics, training experience, body composition and biological maturity of Elite group gymnasts.

METHODS

A total of 84 group gymnasts (18.59±2.44 years of age) from 14 countries were invited and gave consent to participate in the study. Data were collected during the 2009 and 2010 RG World Cups in Portimão, Portugal. This study also had the Scientific Committee of the FIG, team coaches and heads of national delegations consent.

The sample was divided in two groups: the gymnasts from the groups that performed routines with similar apparatus (5 hoops) and those who performed with mixed apparatus (3 ropes and 2 ribbons). After inside each group we organized them in two sub-groups according to their position in the competition ranking (first and second half of the ranking).

Body mass and height were measured using the protocol of Gordon, Chumlea and Roche (Gordon, Chumlea, & Roche, 1988). Thorax (TC), hip (HC), arm (AC), thigh (ThC), waist (WC), and calf (CC) circumferences were measured, and the waist/hip ratio was then calculated. Relative body fat (%BF) was calculated using sex and age-specific equations from 4 skinfold thickness (mm): suprailiac, triceps, thigh and calf. For the gymnasts with less than 18 years, we used the equation of Slaughter et al. (1988) using triceps and calf skinfold thickness. For gymnasts over 18 years old, body density was calculated using the equation developed by Jackson, Pollock & Ward (1980) for females, using triceps, thigh and calf skinfold thickness and then, %BF was calculated using the equation developed by Siri (1961). The fat mass (FM Kg) was calculated using %BF. Body mass index (BMI) was calculated from body mass and height (kg/m²). Absolute lean body mass (LBMkg) and relative lean body mass (%LBM) were calculated using the equation developed by Poortmans, Boisseau, Moraine, Moreno-Reyes, & Goldman (2005) using adjusted circumference of arm, thigh and calf (cm). Biological maturity was determined by the age at menarche; training experience in years was estimated using the initiation age in RG; training volume was defined as hours/week. All does last data were got using a questionnaire answered by the gymnasts.

For the statistical analysis we used the Statistical Package for the Social Sciences - Version 17.0 (SPSS 17.0, Chicago, USA) and Microsoft Office Excel 2007. Descriptive statistics were calculated using the mean values as a measure of central tendency, standard deviation as measures of dispersion and minimum and maximum values as range extent. We analyzed the normality by Kolmogorov-Smirnov and found that the variable distribution in all sample groups followed the normal distribution. Thus, Parametric Test was applied – S*tudent's* t-test for two independent samples, to determine the significant differences between groups.

RESULTS AND DISCUSSION

The results and discussion of our sample was divided in: anthropometric characteristics, body composition variables, training level and age at menarche sections:

Anthropometric characteristics

Gymnast's anthropometric characteristics participants are presented in Table 1. In table 2, we present the chronological age, body mass and height, reported in Rhythmic Gymnastics studies from literature.

There were significant differences in chronological age between the gymnasts of the first half and the second half of ranking in routines with 3 ropes & 2 ribbons. The gymnasts more successful in competition were older (table 1). In Pineau (1994) study, the national level French gymnasts were

14.95±9.4 years old, much lower than our sample. Our study data are closed to other studies with high level RG gymnasts (Amigo et al., 2009; Berlutti et al., 2010; Georgopoulos et al., 1999; Georgopoulos et al., 2002) (Table 2). Nowadays, the increase on gymnast's age in high level competition means an increase of the RG gymnasts' longevity career that can affect the high-level gymnasts new body appearance model. Our sample data for height and weight (table 1) were in accordance with the references values by World Health Organization [WHO] (1995) (163.7cm and 56.6Kg, respectively). We pointed a significant difference between the gymnasts' height when we compared the ranking first and second half for both type of routines. The more successful gymnasts were the taller in both types of routines. Those data were in accordance to similar studies (Amigo et al., 2009; Berlutti et al., 2010; Georgopoulos et al., 1999; Georgopoulos et al., 2002) presented in table 2. Berlutti, et al. (2010) analysed RG gymnasts body composition, biological maturity, dietary habits and anthropometric characteristics during the European Championships of 1986 (Florence) and 2008 (Turin). The group gymnasts included in the sample from Turin had similar height as our sample. But at the 1986 European Championship the authors reporter for group gymnasts lower height (Table 2). Those data means that the high-level gymnasts are now taller than in the past.

As shown in Table 2, Berlutti, at al. (2010) reported a body mass value very close to our data, in 2008 group gymnasts, while for the 1986 group gymnasts they reported a lower value. This can be related to the fact that those gymnasts were younger (approx. less 2 yrs.). The biggest difference found in body mass values between our sample and those in RG studies was in Douda et al. (2008) and Pineau (1994). We believe that those differences were related to the lower age and level of the gymnasts in those two studies. Our results were closer to those from the other studies with group gymnasts and/or with similar age (Amigo et al., 2009; Berlutti et al., 2010; Georgopoulos et al., 1999; Quintero, Martín, & Henríquez, 2011). Apparently, in the past, RG groups were composed by younger and thinner gymnasts than today. Berlutti et al. (2010) reported that the typical thin body profile of RG gymnasts from the past, is not anymore observed nowadays.

We found (table 1) significant differences between circumferences data from the gymnasts of the first and the second half of ranking in 3 ropes & 2 ribbons routines only in arm circumferences. The only available explanation for this difference could be the physical characteristics of those apparatus (deformable) and therefore a constant movement of the arms is needed for a proper apparatus execution. Douda et al. (2008) noted significant lower values of arm circumferences in elite RG gymnasts vs non-elite RG gymnasts. Douda, Laparidis, & Savvas (2002) noted lower values of arm circumferences in RG gymnasts when compared with Artistic gymnasts, but authors in both studies didn't pointed out any reasons for those differences.

Table 1. *Gymnasts Anthropometric characteristics for all sample and in two groups (first half and second half ranking routines in 5hoops and in ropes & ribbons).*

				5 Hoops		3ropes & 2 ribbons	
	All Sample / Ranking (n=84)			First half (n= 42)	Second half (n= 42)	First half (n= 42)	Second half (n= 42)
Variables	Mean (sd)	min	max	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)
Chronological age (years)	18.59 (2.44)	15.27	25.04	18.90 (2.54)	18.28 (2.32)	19.33 (2.35)*	17.86 (2.32)*
Body mass (Kg)	53.05 (4.66)	41.10	63.10	53.97 (4.23)	52.12 (4.93)	53.35 (4.51)	52.75 (4.85)
Height (cm)	168.13(4.95)	156	180	170.24 (5.74)*	166.02(5.15)*	169.71(4.59)*	166.55(4.84)*
Thoracic circumference (cm)	83.14 (3.19)	75.20	90.05	83.30 (3.07)	83.97 (3.34)	83.16 (3.53)	83.12 (2.86)
Hip circumference (cm)	88.07 (3.94)	76.50	98.10	88.06 (3.60)	88.07 (4.30)	87.91 (3.40)	88.22 (4.45)
Arm circumference (cm)	23.51 (1.68)	20.20	27.50	23.31 (1.62)	23.75 (1.73)	23.13 (1.48)*	23.93 (1.80)*
Thigh circumference (cm)	52.22 (2.79)	45.30	57.50	52.11 (2.62)	52.32 (2.97)	52.08 (2.54)	52.35 (3.04)
Waist circumference (cm)	67.05 (3.22)	58.50	74.10	66.36 (2.71)	67.73 (3.56)	67.50 (2.79)	66.59 (3.57)
Calf circumference (cm)	34.03 (1.61)	30.90	37.00	34.32 (1.61)	33.75 (1.56)	34.01 (1.61)	34.05 (1.62)

*Significant differences for $p<0.05$ (T-test analysis).

Table 2. *Age, body mass and height (Mean ± standard deviation) previously reported in rhythmic gymnasts.*

Variables/ Authors	Sample (n)	Level of performance	Chronological age (years)	Body Mass (Kg)	Height (cm)	Height percentile	Weight percentile
Pineau (1994)		National (France)	14.95±9.4	40.8±3.3	162±4.5		
		International (Germany)	16±1	49.4±2.2	164.7±4.6		
		International (Italy)	16.4±0.5	46.6±3.1	159±2.2		
Georgopoulos et al. (1999)	255	EC 1997	14.73 ±2.12 (11 a 23)	42±7.37	160.4±7.4	> 50	< 50
	16	EC 1997	18.43±2.09 (15 a 23)	52.4±5.1	168.2±5.2		
Georgopoulos et al. (2001)	104	EC and WC 1997-2000	16.0±1.7 (12-23)	45.3±6.6	163.6±5.6	> 50	
Georgopoulos et al. (2002)	129	WC 1999	17.1±1.4	47.3±4.8	166.3±4.6	> 50	< 50
Douda et al. (2002)	9	National (Greece)	(15-17)	44.07±3.61	160.40±4.83		
Theodoropoulou et al. (2005)	423	WC and EC 1997 to 2004	15.90±2.40			> 50	< 50
Douda et al. (2008)	15	International Greece and Cyprus	13.41±1.62	35.60±5.46	151.06±9.50		
Amigo et al. (2009)	151	National International (Spain)	18.2±0.18	53.7±3.28	170.8±2.86	90	25
Berlutti et al. (2010)	139	EC Groups 2008	18.8±2.2	52.4±4.5	168.9±5.6		
		EC Groups 1986	16.4±2.1	49.5±5.5	164.8		
Quintero et al. (2011)	15	Canary club championship 2008	(15-19)	51.3±5.6	162.95±6.1		

Legend: EC = European Championship; WC = World Championship.

Table 3. *Body composition variables for all sample and in two groups (first half and second half ranking routines in 5hoops and in ropes & ribbons). Data are mean (SD).*

				5 Hoops		3ropes & 2 ribbons	
	All Sample / Ranking (n= 84)			First half (n= 42)	Second half (n= 42)	First half (n= 42)	Second half (n= 42)
Variables	Mean (sd)	min.	max.	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)
BMI (Kg/m^2)	18.75 (1.30)	16.14	21.75	18.61 (1.14)	18.90 (1.44)	18.50 (1.09)	19.01 (1.45)
BF (%)	16.74 (2.87)	10.28	23.81	16.60 (3.23)	16.88 (2.50)	15.96 (2.74)*	17.53 (2.81)*
FM (Kg)	8.92 (1.89)	5.48	13.83	9.02 (2.13)	8.82 (1.63)	8.56 (1.91)	9.27 (1.82)
LBM (Kg)	26.31 (2.78)	20.31	32.23	26.57 (2.61)	26.05 (2.95)	26.50 (2.60)	26.12 (2.96)
LBM (%)	49.56 (2.39)	44.66	57.36	49.19 (2.34)	49.94 (2.40)	49.65 (2.16)	49.48 (2.61)
Waist/Hip circumference (cm)	0.76 (0.03)	0.68	0.85	0.75 (0.03)	0.77 (0.04)	0.77 (0.03)	0.76 (0.04)

Legend: BMI = Body Mass Index; BF = Body Fat; FM = Fat Mass; LBM = Lean Body Mass
*Significant differences for $p<0.05$ (T-test analysis) max and min

Table 4. *Body composition data (mean ± standard deviation) previously reported in rhythmic gymnasts.*

Variables/ Authors	Sample (n)	Sample (RG gymnasts)	Age (years)	BMI (Kg/m^2)	BF (%)	LBM (Kg)	LBM (%)	FFM (Kg)	Waist/Hip circumference (cm)
Pineau (1994)		National (France)	14.95±9.4	15.5±0.5	13.2±0.4				
		International (Germany)	16±1	18.2±0.6	16.8±1.6				
		International (Italy)	16.4±0.5	18.4±0.8	15.5±1.8				
Georgopoulos et al. (1999)	255	EC 1997	14.73 ±2.12 (11 a 23)	16.26±1.82	16.1±4.07				
	16	EC 1997	18.43±2.09 (15 a 23)	18.52					
Georgopoulos et al. (2001)	104	EC and WC 1997-2000	16.0±1.7 (12-23)	16.8±1.8	15.9±4.9				
Georgopoulos et al. (2002)	129	WC Osaka 1999	17.1±1.4	17.1±2.1	13.1±4.9				
Douda et al. (2002)	9	National (Greece)	(15-17)		14.33±2.80				
Theodoropoulou et al. (2005)	423	WC and EC 1997 to 2004	15.90±2.40	16.9±1.80	15.5±4.60				
Douda et al. (2008)	15	International Greece and Cyprus	13.41±1.62		13.97±2.18	29.84± 1.81			
Amigo et al. (2009)	10	National International (Spain)	18.2±0.18		11.3±1.43		47.7±1 .69	47.6±3 .23	
Berlutti et al. (2010)	139	EC Groups 2008	18.8±2.2	18.3±1.3	17.6±3				0.75±0.03
		EC Groups 1986	16.4±2.1	18.1±1.5	14.4±3.8				
Quintero et al. (2011)	15	Canary club championship 2008	(15-19)		11.99±1.5		49.89 ±1.1		

Legend: EC = European Championship; WC = World Championship; BF (%) = Body Fat; BMI = Body Mass Index; LBM = Lean Body Mass; FFM = Fat Free Mass.

Body composition

Body composition variables are presented in Table 3. Body composition data from literature are resumed in table 4.

According to Amigo et al. (2009), the most used parameters of body composition in sports are BF and LBM. However, in RG studies, the BF and BMI were the most frequently used parameters. The BMI values in our sample (table 3) were close to lower limit of the normal range by the WHO (2000) (18.50 to 24.99 kg/m^2). In table 4 we can see that older gymnasts from other studies (Berlutti et al., 2010; Georgopoulos et al., 1999) had higher BMI than the younger ones (Pineau, 1994; Theodoropoulou et al., 2005). Some authors (Berlutti et al., 2010; Georgopoulos et al., 1999; Georgopoulos et al., 2001; Pineau, 1994; Theodoropoulou et al., 2005) reported %BF values closed to ours, studding gymnasts with similar and lower age than our sample. However, we found also some authors that reported lower values of %BF than our study (Amigo et al., 2009; Douda et al., 2002; Douda et al., 2008; Georgopoulos et al., 2002; Pineau, 1994; Quintero et al., 2011) maybe because the gymnasts in these studies were mostly younger than ours, and not so high level gymnast than our sample (table 4). All gymnasts from these studies competed in individual competition, which may have influenced the results. In individual competition the subjective aesthetic evaluation from judges is more focused on the gymnast profile while in group competition is more focused on the group work design (Vitrichenko et al., 2011).

In our study, the first half ranking gymnasts had lower values of %BF than the second half ranking gymnasts. Even for both kind of apparatus differences were found, only in 3 ropes & 2 ribbons routines the differences were significant. The %BF that Amigo et al. (2009) recorded in Spanish gymnasts was much lower than reported in other studies (including our study) and also lower than the reference values of the Spanish population. The author pointed out that the gymnasts in the different studies had different training requirements, were assessed at different times of the season, and had different diets, that can had influence on the results difference. Quintero et al. (2011) had also %BF much lower than what we and other studies have shown (table 4), according the author the %BF, FM (Kg), LBM (Kg and %) had no effect the good results in their sample. Analysing our results and those from the literature we could observe that as the sample level is lower the %BF is also lower. So we could see that lower %BF is not a measure of success in rhythmic gymnastics nowadays.

The LBM (Kg) values of our study were close to those reported by Douda et al. (2008) in international RG gymnasts from Greece and Cyprus (Table 4). According to Amigo et al. (2009) the LBM (%) measured in Spanish gymnasts (national and international level) with a mean age of 18.2 years was significantly higher than the reference value for the Spanish population. In addition, they reported that the LBM of the 15 to 18 years old gymnasts did not differ significantly with age. In our sample we did not remark differences on the LBM (Kg or %) for the different sample groups. The gymnasts from our sample were composed by the best group gymnasts in the world, if even they were placed in the second half of ranking on the world cup competition, and all gymnasts were submitted to a high intensity level training. According Lisitskaya (1995) LBM (%) in GR Elite gymnasts must be around 47-50%. The results for our sample are in according to this requirement.

Berlutti et al. (2010) observed that the group gymnasts had a waist/hip ratio less than 0.78 cm, what, for authors defines a gynoid biotype. The results for all sample in our study were 0.76 cm witch was very close to that appointed by these authors.

Training level

Training data for all gymnasts in the sample are presented in Table 5. In Table 6 are resumed the data from the studies in RG that analysed training data.

In Table 5 we can see that the gymnasts from our sample began the RG practice at 6.46 years of age although, the lower limit was 4 years old and higher 10 years old. According to Berlutti, et al. (2010), the gymnasts who participated in the 2008 European championship began the practice of RG at 6.2 years old but the gymnasts who participated in the 1986 European Championship had started at 7.8 years of age suggesting that the beginning in RG is becoming earlier. All other studies (Table 6) have reported beginning age in RG between 6.8 years old (Georgopoulos et al., 1999) and 7.7 years old (Georgopoulos et al., 2002). When we compare the gymnasts from ranking first half with the ranking second half in both types of routines, we observed significant differences between groups, being the ranking first half gymnasts who began earlier the activity in RG.

In our study the gymnasts have been in RG for 12 years. The range was between 7 and 20 years of practice. When we compared the groups according to their position on the ranking, in both type of routines, we observed significant differences between groups, being the gymnasts from the more successful groups those who had more years of RG practice.

The gymnasts from our study trained 6.8 hours daily, but we could see a range from 4.5 hours/day to 8.5 hours/day. This difference is clearly reflected in the weekly training volume. The groups participating in World Cup of Portimão trained 40.5 hours/week (mean value for all sample). Only Berlutti, et al. (2010) refers to the daily training of RG gymnasts, so we can see in Table 6 that the gymnasts who participated in the 2008 European championship trained 6 hours daily, however the authors noted trained range between 3 hours to 10 hours per day. In the same study (Berlutti et al., 2010) reported 3.8 hours of daily training for the gymnasts who participated in the 1986 European Championship. In our study, when we compared the ranking first half with the ranking second half gymnasts, for both type of routines, we observed significant differences between groups on training duration (hours/day). The ranking first half gymnasts trained more hours/day and more hours/week than the others.

Table 5. *Training data for all sample and in two groups (first half and second half ranking routines in 5hoops and in ropes & ribbons). Data are mean (SD).*

				5 Hoops		3 ropes & 2 ribbons	
	All Sample / Ranking (n=84)			First half (n= 42)	Second half (n= 42)	First half (n= 42)	Second half (n= 42)
Variables	Mean (sd)	min.	max.	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)
Age of initiation in RG (years)	6.46 (1.54)	4	10	6.12 (1.17)*	6.81 (1.78)*	6.10 (1.12)*	6.83 (1.81)*
Practice (years)	11.99 (2.61)	7	20	12.69 (2.88)*	11.29 (2.12)*	13.14 (2.78)*	10.83 (1.82)*
Training duration (hours/day)	6.82 (1.12)	4.5	8.5	7.21 (0.93)*	6.43 (1.16)*	7.07 (0.87)*	6.57 (1.28)*
Training Volume (hours/week)	40.50 (6.43)	27	51	42.43 (5.24)*	38.57 (6.97)*	41.57 (4.71)	39.43 (7.69)

*Significant differences for $p<0.05$ (T-test analysis).

Table 6. *Training data (mean ± standard deviation) previously reported in rhythmic gymnasts.*

Authors/ Variables	Georgopoulos et al. (1999)		Georgopoulos et al. (2001)	Georgopoulos et al. (2002)	Theodoropoulou et al. (2005)	Berlutti et al. (2010)	
Sample (n)	255	16	104	129	423	139	
Sample (RG gymnasts)	EC 1997	EC 1997	EC and WC 1997-2000	WC 1999	WC and EC 1997 to 2004	EC Groups 2008	EC Groups 1986
Age (years)	14.73 ±2.12 (11 a 23)	18.43±2.09 (15 a 23)	16.0±1.7(12-23)	17.1±1.4	15.90±2.40	18.8±2.2	16.4±2.1
Onset RG (years of age)	6.82±1.92		7.3±2.3	7.7±2.2	7.4±2.3	6.2±1.9	7.8±2.8
Training/day (hours)						6±1.8	3.8±1.6
Training/week (hours)	29.14±15.35		32.5±13.5	31.2±9.6	27.1±10.40	36	21.66

Legend: EC = European Championship; WC = World Championship

Table 7. *Age at menarche data for all sample and in two groups (first half and second half ranking routines in 5hoops and in ropes & ribbons). Data are mean (SD).*

				5 Hoops		3 ropes & 2 ribbons	
	All Sample / Ranking (n=52)			First half (n= 22)	Second half (n=30)	First half (n= 22)	Second half (n=30)
Variables	Mean (sd)	min.	max.	Mean (sd)	Mean (sd)	Mean (sd)	Mean (sd)
Menarche (age)	15.92 (1.40)	13	18	16,05 (1,53)	15,83 (1,32)	15,86 (1,46)	15,97 (1,38)

Table 8. *Age at menarche (mean ± standard deviation) previously reported in rhythmic gymnasts.*

Authors/ Variables	Georgopoulos et al. (1999)		Georgopoulos et al. (2002)	Theodoropoulou et al. (2005)	Berlutti et al. (2010)	
Sample (n)	255	16	129	423		139
Sample (RG gymnasts)	EC 1997	EC 1997	WC 1999	WC and EC 1997 to 2004	EC Groups 1986	EC Groups 2008
Age (years)	14.73 ±2.12 (11 a 23)	18.43±2.09 (15 a 23)	17.1±1.4	15.90±2.40	16.4±2.1	18.8±2.2
Menarche (age)	14.3±1.46		15.2±1.4	14.6±1.50	14±1.3	15.9±1.3

Legend: EC = European Championship; WC = World Championship

Age at menarche

From the 52 gymnasts who answered about the menarche age (table 7), 86.7% said that they had already menarche and 13.3% were not menstruating (these gymnasts were between 15 and 16 years old).

The mean age at menarche reported in our sample was 15.92±1.40 years. Georgopoulos, et al. (2002) reported that 28.65% of the gymnasts in their study (which participated in 1999 Osaka World Championships) had not reached menarche. Also Theodoropoulou, et al. (2005) reported, in Elite gymnasts in 1997 to 2004 World Cup and European Championship, that 16.8% had no menarche. As shown in Table 8 Berlutti, et al. (2010) also reported a mean age at menarche of 15.9 years old, similar to our sample. Those values were higher than the described to normal population (Berlutti et al., 2010). The authors noted, that the 1986 Florence European Championship, the age at menarche was lower (14 years old) than that observed today. Theodoropoulou, et al. (2005) described also an later age of menarche in RG gymnasts (14,6 years old). Beunen et al. (1994) relates the precocious onset of menarche with a high %BF and the delayed onset of menarche with low rates of %BF. The %BF noted in our study and in the other in RG studies was not measured gymnasts at the moment of the menarche onset and, so, we cannot discuss if the %BF was the main reason for the delayed menarche in these gymnasts.

Wilmore & Costill (1999) noted that the menarche onset was later in highly trained elite athletes (such as in gymnastics) but made it clear the fact that there is still no evidence supporting the idea that the intensive training delayed menarche. Also Cumming, et al. (2011) said that there were some evidence in the inverse relationship between maturational status and physical activity. In addition, considering that the Elite gymnasts trained 30 to 40 hours/week we may say that the biggest difference between the gymnasts in the older studies and the gymnasts in most recent studies is the weekly training volume that has increased over the years.

Two studies reported significant differences between age at menarche of gymnasts, and the menarche age of their mothers and non-gymnast sisters suggesting the delayed menarche may not have a genetic origin (Georgopoulos et al., 1999; Theodoropoulou et al., 2005).

In our study we observed a similar age for menarche onset than those described in recent literature (Berlutti et al., 2010; Georgopoulos et al., 2002; Theodoropoulou et al., 2005).

The data collected cannot give enough information to point that the late onset of menarche in elite gymnasts is due to the low %BF, or genetic factors or the training intensity. However, we think that maybe also are unconscious selection of the gymnasts who had late maturate profile because the RG typical body appearance.

CONCLUSIONS

Analysing the results discussions we could conclude that the high-level gymnasts are, nowadays, older and higher than in the past; and also the more successful gymnasts were older, higher and with more body mass.

The Elite group RG gymnasts had BMI, high and body mass values at the normal range whatever the success in competition. The more success group gymnasts had lower %BF values but still higher than what have been reported in RG studies in the past. We could see that lower %BF is not a measure of success in rhythmic gymnastics nowadays. LBM (Kg or %) values were in accordance to reference values for Elite RG and had no effect on the results.

The more successful gymnasts began earlier the RG, had more years of practice, train more hours a day and had more weekly training volume. The Elite group RG gymnasts had a later onset of menarche than normal population. We think that also are unconscious selection of the gymnasts who

were late maturate in initial selection of the gymnasts in this sports because them body appearance.

We believe that this study is a strong contribution to update the knowledge about the success elite RG gymnasts. The increase on gymnasts age in high level competition could mean an increase of the RG gymnasts longevity, that affect the new body appearance model of high-level gymnasts. In groups competition we think that Elite RG body composition had no direct effects on the results because the subjective aesthetic evaluation that judges do in groups competition is more focused on the design of the group work.

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