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The anthropometric profile of elite roller figure skaters

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ABSTRACT

Vila MH, Abraldes JA, Rodríguez N, Manchado C, Ferragut C. The anthropometric profile of elite roller figure skaters. *J. Hum. Sport Exerc.* Vol. 8, No. Proc3, pp. S633-S641, 2013. Although the anthropometric profiles of Olympic athletes, as a group, are well known, there is still a need for specific reference data for each sport given that each discipline has its own characteristics. This study has been designed considering the limited number of articles that focus on the anthropometric characteristics of artistic roller skating and, more specifically, the figures discipline. The aim of this study is twofold: firstly, to define the anthropometric profile, body composition and somatotype of male and female artistic roller figure skaters in order to establish specific profiles; and, secondly, to establish the differences between the anthropometric profiles, body compositions and somatotypes of male and female skaters. Twenty-nine professional roller skaters (male = 15, female = 14) underwent measurements of standard anthropometry (height, body mass, arm span, 8 skinfolds, 3 breadths and 11 girths). The somatotype was measured using the Heath-Carter methods. A T-Student test for independent samples was conducted in order to assess the differences between male and female skaters. Significant statistical differences were found between male and female skaters in terms of body mass, height, arm span, the sum of four and six skinfolds and all skinfold measurements. Male skaters have a BMI of 21.4± 1.6 and female skaters have a BMI of 21.5 ± 2.4. The results indicate that arm span is an important characteristic for skaters. Mesomorphy is the most important component, followed by endomorphy, for male and female skaters. Male skaters have an endo-mesomorphic somatotype (3.5-4.5-2.5) and female skaters have a balanced mesomorphic somatotype (3.3-4.1-2.9). **Key words**: SOMATOTYPE, PERFORMANCE, COMPETITION, GENDER.

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INTRODUCTION

Although not currently part of the Olympic Games, roller skating has had an international federation since 1924 and includes four disciplines: Artistic, Speed, Hockey and Inline skating. Within artistic roller skating, there are four disciplines – two in which skaters compete individually (figures and singles) and two which are performed as duets (pairs and dance).

The figures discipline, also known as school figures, is often used as an introduction to skating competitions. Thus, skaters who compete in this discipline are at the beginning of their sporting career. There are a number of differences with regards to the other three disciplines – figure skating does not include choreography with different elements and levels of difficulty, and physical appearance is not a deciding factor in scoring. Skaters trace figure circles painted on the skating surface, measuring 6 and 2.4 meters in diameter. Circles are painted in the shape of "serpentines", with sets of three circles. The figures are the same as those in ice skating, and consist of drawing eights on one foot.

Although the anthropometric profiles of Olympic athletes, as a group, have already been published by Carter (1982), there is still a need to define “specific reference data for each sport” given that each discipline has its own characteristics (Norton & Olds, 2001). In order to establish these specific profiles, we need to collect data on various anthropometric measurements in standard circumstances, using a sufficient number of elite athletes belonging to the same sport, discipline or event. While there are a number of studies that analyse the physical characteristics of top skaters, both male and female, in artistic ice skating, we have not found any similar studies on artistic roller skating.

Scientific literature states that the stereotype of artistic ice skaters is characterised by linearity and leanness (Monsma & Malina, 2005; Ross et al., 1977; Vadocz et al., 2002; Ziegler et al., 2001a). Female ice skaters have a smaller build (Vadocz et al., 2002; Ziegler et al., 2001b), while male ice skaters have a more upright, lean and muscular body, especially when it comes to their trunk (Podolsky et al., 1990; Ziegler et al., 2001b).

This study has been designed considering the limited number of articles that focus on the anthropometric characteristics of artistic roller skating and, more specifically, the figures discipline. The aim of this study is twofold: firstly, to define the anthropometric profile, body composition and somatotype of male and female artistic roller figure skaters in order to establish specific profiles; and, secondly, to establish the differences between the anthropometric profiles, body compositions and somatotypes of male and female skaters.

MATERIAL AND METHODS

Sample

A total of 29 roller skaters (15 male and 14 female) volunteered to participate in this study. Volunteers were recruited from participants in the 51st artistic roller skating world championship (2006) participating in figure discipline. A total of 80% of the participants in figure discipline were evaluated; in this group including the winners. Asian roller skaters were excluded from the study. Physical characteristics of roller skaters are shown in Table 1.

Procedure

The study was approved by the San Antonio Catholic University Committee for research involving human subjects and carried out according of the Declaration of Helsinki. All participants received verbal and written

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information about the study and gave written informed consent before anthropometric and conditional assessment Additional background information was provided by each roller skater, including date of birth, skate discipline and the number of years skating. Subjects were measured during one session, two days prior the championship started, and all of them were in a postprandial state. All the subjects were well hydrated and they were instructed to consume food and to drink as usual during the breakfast in the day when the measured were realized.

The International Society for the Advancement of Kinanthropometry (ISAK) (Stewart, Marfell-Jones, Olds & Ridden, 2011) guidelines was used to determine the anthropometric profile of the roller skaters. Unilateral measurements were taken on the right side of the body. Participants wore light clothing and were barefoot. Anthropometric assessment was made on those parameters considered of importance for success in the sport in general and for roller skating in particular (Carter, 1970; Monsma & Malina, 2005; Ross et al., 1977).

Physical characteristics were measured in the following order: height, body mass, arm span, skinfolds, body girths and skeletal breadths. The anthropometric program included 25 measurements. Height and weight measurements were made on a set of scales (Seca, Barcelona, Spain) with an accuracy of 0.01 kg and 0.001 m, respectively. Arm span was measured using an anthropometer (GPM, Switzerland) with an accuracy of 0.01cm, as the distance between the tips of the largest digits on each hand with the arms stretched out horizontally. Eight skinfolds (triceps, subscapular, biceps, abdominal, iliac crest, supraspinale, front thigh and medial calf) were measured by Holtain Skinfold Caliper with 10 g.mm-2 constant pressure and an accuracy of 0.2 mm. Eleven limb and trunk girths (arm relaxed, arm flexed and tensed, forearm, wrist, chest, waist, gluteal, upper Thigh (1 cm gluteal), medium Thigh (mid-troch-tib. lat.), calf and ankle) were measured using a Lufkin metal tape, (Lufkin Executive Thinline, W606PM, USA) and three skeletal breadths (biepicondylar-humerus, biepicondylar femur and bistyloid) were measured using an anthropometer (GPM, Switzerland) with an accuracy of 0.01 cm.

The anthropometric dimensions were measured twice (three times for skinfolds) and were obtained by one accredited level II and three accredited level I ISAK anthropometrists. The margin of error for the measurement was <2% for all skinfolds and <1% for all bone breadths and body girths.

Additionally, several variables were derived: a) the body mass index (BMI) was calculated as weight (kg) divided by height squared in meters (m2), b) sum of four (triceps, subscapular, supraspinale and abdominal) and six skinfolds (triceps, subscapular, supraspinale, abdominal front thigh and medial calf), c) selected anthropometric measures were used to determine somatotype following the methods described by Carter & Heath (1990). For further analysis and comparisons of the somatotype, the somatotype dispersion index (SDI) was calculated by dividing the sum of the somatotype dispersion distance (SDD) from mean somatopoint by the number of subjects (n) (Carter, 1970).

Statistical analysis

Statistical analyses were performed using the SPSS package (15.0 version; SPSS, Inc., Chicago, IL, USA). Standard statistical methods were used to calculate the mean and standard deviations. The normality of the variables was evaluated through the Kolgomorov–Smirnov test with Lilliefors correction and Levene t-tests for non- matching samples. Afterwards, a T Student test was used to determine if significant differences existed in anthropometric profile between gender. The $p \leq 0.05$ criterion was used for establishing statistical significance.

RESULTS

We found significant differences between gender in skinfolds, but these differences were very significant (p£0.001) for triceps, biceps and front thigh skinfolds (Table 1).

Table 1. *Mean and standard deviations values ($\bar{x} \pm sd$) correspondent to anthropometric characteristics of roller figure skaters*

	Male (n=15)	**Female (n=14)**
Age (yrs)	20.6±3.3	19.7±2.7
Body Mass (kg)	65.9±8.0*	57.3±6.6
Body Height (cm)	175.3±6.5**	168.4±4.6
Arm span (cm)	178.5±7.4**	164.8±4.6
Body Mass Index (Kg/m^2)	21.2±21.6	21.5±2.4
Σ 4 Skinfolds (mm)	36.6±6.4**	57.2±17.2
Σ 6 Skinfolds (mm)	67.8±14.5**	108.4±30.1
Arm relaxed (cm)	27.1±3.5	25.6±2.8
Arm flexed and tensed (cm)	28.4±3.5	26.8±2.4
Forearm length (cm)	24.0±2.2	23.3±2.4
Wrist length (cm)	15.2±1.0	15.2±1.2
Chest (cm)	88.2±4.1	80.4±15.1
Waist (cm)	70.0±6.8	68.4±8.6
Gluteal (cm)	99.4±13.2	91.3±10.6
Upper Thigh (cm)	55.5±3.9*	54.5±3.7
Medium Thigh (cm)	51.3±4.7	49.6±4.2
Calf (cm)	35.7±3.0	33.7±3.4
Ankle (cm)	22.7±3.2	21.5±2.2
Biepicondylar humerus (cm)	6.2±0.4	6.2±0.8
Biepicondylar femur (cm)	10.2±1.3	9.2±1.0
Bistyloid breadth (cm)	5.0±0.5	5.0±0.4
Endomorphy	3.6±0.7	3.3±1.0
Mesomorphy	4.5±1.3	4.1±1.0
Ectomorphy	2.5±0.9	2.9±0.9
SDI	3.5±2.1	3.2±1.2

Significant differences between genders *(*)* p≤0.05; (**) p≤0.001

Sum of skinfolds and breadth values of the roller figure skates are shown in Table 1. Significant differences were found in sum of four and six skinfolds between gender.

Regarding girths, no differences were found between gender, with the exception of upper thigh (p£0.05). No differences were found for somatotype between gender and SDI show that both are heterogeneous group.

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DISCUSSION

Anthropometric data are very useful tools in the assessment of athletes. However, having reviewed international scientific publications, we have not found any similar studies on male and female artistic roller figure skaters with which to carry out the discussion. It is for this reason that the discussion will be based on a comparison with artistic ice skaters, focusing on the variables in which a comparison is possible, given the similarities between both disciplines (Barkoff & Heiby, 2004).

Male skaters

A comparison of the average age, height, weight and BMI of elite male skaters can be seen in Table 1. The ages vary between 16.5 (Ziegler et al., 1999) and 20.6 (current study). Figure skaters are taller and heavier than those in other studies (Ross et al., 1977; Ziegler, Jonnalagadda et al., 2001; Ziegler et al., 1999; Ziegler et al., 2001b, 2003, 2005), with the exception of Jonnalagadda, Ziegler & Nelson (2004). Their BMI is within the normal range, but is lower than those found in other studies (Table 2).

Table 2. *Published researchers in male ice skaters*

Research	Sample	Age	Weight	Height	BMI
National Figure Skating Champioships 1994. (Ziegler et al., 1999).	21	16.5 ± 1.6	63.6 ± 8.9	169.5 ± 8.1	22.1
Élite Figure Skaing Nacional Championships 2001. (Ziegler et al., 2003).	46	16.9 ± 0.3	64.7 ± 1.6	172.0 ± 0.01	21.5 ± 2.3
Ziegler et al. (2005).	79	18.4			22.3
Canadian Figure Skaters. (Ross et al., 1977).	12	18.2 ± 3.6	56.5 ± 8.2	164.4 ± 7.3	
Jonnalagadda et al. (2004).	23	19 ± 4.0	67.8 ± 3.1	151.0 ± 23.0	22.9 ± 3.3
Ziegler, Nelson et al. (2001).	80	18.4 ± 3.6	65.2 ± 8.9	171.7 ± 8.0	22.0 ± 16.1
Present study	13	20.5± 3.3	65.9 ± 8.0	175.3 ± 6.5	21.2 ± 1.6

The skaters in this study have an endo-mesomorphic somatotype. When compared to other studies on ice skaters (Ross et al., 1977) (ecto-mesomorphic), we found that their somatotypes are not the same. However, mesomorph is the dominant component in both studies as it is linked to athletic performance (Cabañas & Esparza, 2009).

Female skaters

The age, weight, height and BMI measurements of the skaters in the publications cited in Table 3 (Jonnalagadda et al., 2004; Monsma & Malina, 2005; Ross et al., 1977; Ziegler et al., 2001b) are lower than those in this study. The greater dimensions of the skaters in this study can be linked to the fact that artistic roller figure skaters are older. The BMI of the athletes in this study is within the normal range, which may be surprising given the emphasis placed on physical appearance and linearity in this sport (Monsma & Malina, 2005; Ross et al., 1977; Vadocz et al., 2002; Ziegler et al., 2001b). The studies on ice skaters (Monsma & Malina, 2005; Ross et al., 1977) show lower breadths (biepicondylar humerus and

biepicondylar femur) and girths (arm relaxed, arm flexed, upper thigh and calf) than artistic roller figure skaters.

Table 3. *Published researchers in female ice skaters*

Research	Sample	Age	Weight	Height	BMI
National Figure Skating Championships 1999. (Ziegler et al., 2002)	48	15± 2.4	-	-	18.5 ± 2.0
Ziegler, Nelson et al. (2001).	81	15.9 ± 3.6	47.8 ± 6.3	157.1 ± 7.2	19.3 ± 13.5
Canadian Figure Skaters. (Ross et al., 1977)	18	15.7 ± 1.6	48.6 ± 6.0	156.8 ± 5.0	-
Jonnalagadda et al. (2004).	26	15.5 ± 2.6	-	-	18.6 ± 2.0
Elite. (Monsma & Malina, 2005)	47	17.7 ± 2.2	53.9 ± 5.4	159.3 ± 5.5	21.2 ± 1.9
Present study	14	19.7 ± 2.7	57.3 ± 6.6	164.8 ± 4.6	21.5 ± 2.4

Female skaters have a balanced mesomorphic somatotype – with mesomorph being the main component, followed by endomorph. The endomorphic body type develops normally, growing from childhood through to adolescence. The mesomorphic and ectomorphic body types, however, are slightly different (Malina, Bouchard & Bar Or, 2004). The mesomorph body type tends to decrease with age within the female population, but this is not the case in this study. This may suggest that female skaters undergo a strict selection process. We have only found two studies that analyse the somatotypes of elite female skaters, and their data is very different – one of them coincides with our data (Ross et al., 1977), while the other described a mesomorphic-endomorphic somatotype (Monsma & Malina, 2005).

Male skaters vs female skaters (comparison)

Height, weight and body mass measurements give us an idea of the dimensions of the male and female skaters we have studied. The male measurements are greater than those of the females, and there are significant differences in the three variables. These results coincide with those of the general population (Malina et al., 2004). In this study, the average body mass of both males and females was greater than their height, which means that height is linked to the body mass being greater than expected in normal growth patterns (Malina et al., 2004).

The female skaters have greater skinfold measurements than the male skaters, and there are significant differences in all the cases. This data confirms the differences between girls and boys with regards to the development of body fat. Girls experience a greater increase in body fat, especially when they reach puberty (Malina et al., 2004). This phenomenon was confirmed with the results of this study, revealing the sexual dimorphism in body fat.

The sum of skinfolds (body adiposity index) follow the same pattern as described above. Female skaters were found to have greater skinfold measurements, with significant differences in the sum of six and four skinfolds. These results coincide with those of other studies (Malina et al., 2004; Fragoso & Vieira, 2000) with regards to trunk and limb skinfolds and with the fact that the percentage of body fat in teenage girls is, approximately, double that of boys. This means that, despite the importance of leanness and linearity in artistic roller figure skating (Vadocz et al., 2002; Ziegler et al., 2001b), skaters' training does not seem to influence the normal growth of body adiposity. This could be explained by the fact that physical appearance is less important in this discipline, as scoring is more objective.

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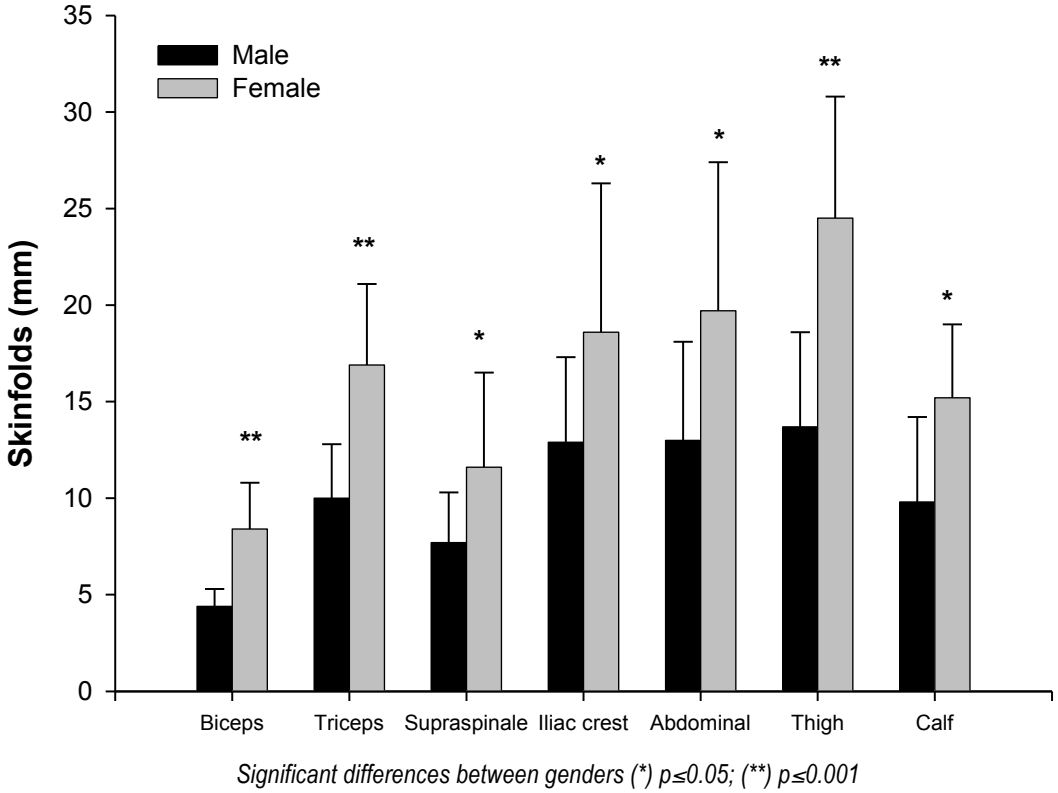

Figure 1. *Skinfolds values of roller figure skaters*

There are no significant differences with regard to breadth and girths, with the exception of greater thigh girth measurements in male skaters. These results may be due to the fact that figure skating does not require special strength, given that it does not involve doing figures in the air, turns, lifts or jumps.

Male skaters have an endo-mesomorphic somatotype and female skaters have a balanced mesomorphic somatotype. Mesomorph is the dominant body type in both males and females. Male and female skaters tend to be lower on the ectomorphic component than on endomorph, which does not coincide with the results of other studies (Harris, 1986; Monsma & Malina, 2005; Patel et al., 2003; Ross et al., 1977; Sundgot-Borgen, 1994; Vadocz et al., 2002; Whisenhunt et al., 2008), where male skaters tend to be higher on the ectomorphic component than on endomorph. This may indicate that, within roller skating, the figures discipline has a different somatotype to the other three disciplines (singles, pairs and dance). The SDI results prove that both male and female skaters are not part of a homogeneous group.

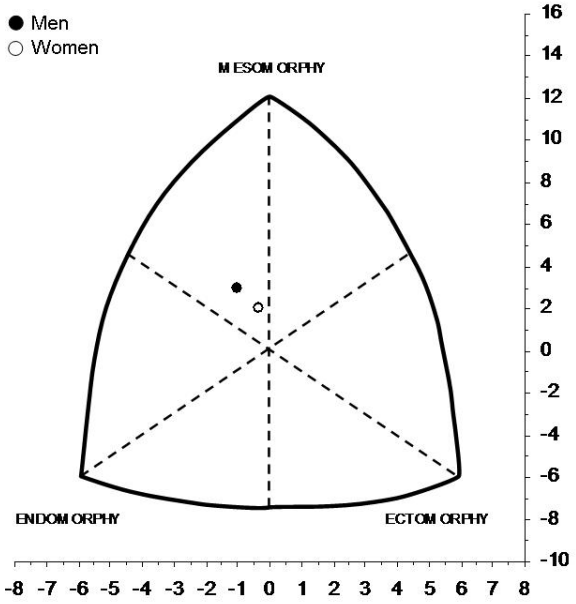

Figure 2. *Somatochart of roller figure skaters*

CONCLUSIONS

Anthropometric reference data for specific groups of elite athletes belonging to a particular sport may be a very useful tool for professional skating, both in terms of training and talent-spotting.

The weight, height and body mass measurements of male skaters are greater than those of female skaters, but female skaters have greater skinfold measurements and higher values in the sum of six and four skinfolds than male skaters.

Body mass is an important characteristic in this sport, with both male and female skaters presenting higher values than the general population.

Mesomorphy is the most important component, followed by endomorphy, for male and female skaters.

Male skaters have an endo-mesomorphic somatotype and female skaters have a balanced mesomorphic somatotype.

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