Body composition profile of young inline speed skaters

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Summary

The aim of this work was to determine the body composition profile of children and young roller skaters. 516 athletes (361 males and 155 females) between the ages of 5 and 21 years old, who belong to official clubs in Colombia and Venezuela, were evaluated longitudinally. The anthropometric variables were taken according to ISAK, using the Holtain© caliper for the skin folds (triceps, anterior thigh and medial leg) and the Sanny© tape for the perimeters (relaxed arm, medial thigh and leg). The treatment for the estimation of the percentage of body fat (%F) and muscle mass (%MM) was performed under the protocol of the GREC and processed by means of SPSS 24.0. The results point to the existence of significant differences ($p<0.05$) between sexes for %F and %MM. For the development of the profile the methodology of smoothed curves was used with the application of the software LMS Chart Maker© and to generate cut points for the percentiles 3, 10, 75, 90 and 97. It is concluded, that the classification for the proposed body composition, without trying to be a unique norm to establish the typification of the status of the body composition of a skater, allows to distinguish and to categorize with rigor and objectivity, the characteristics of the body composition of the skaters independently of the age and competitive level. This work is recommended as a starting point for future studies in larger populations with established probability sampling and ethnicity.

Perfil de composición corporal en niños y jóvenes patinadores de velocidad sobre ruedas

Resumen

El objetivo del presente trabajo fue determinar el perfil de composición corporal en niños y jóvenes patinadores de velocidad sobre ruedas. Se evaluaron, longitudinalmente, 516 deportistas (361 Femeninos y 155 Masculinos) con edades comprendidas entre 5 y 21 años, patinadores de velocidad sobre ruedas, pertenecientes a clubes oficiales en Colombia y Venezuela. Las variables antropométricas se tomaron de acuerdo a lo dispuesto por ISAK, utilizando el calibrador Holtain© para los pliegues cutáneos (tríceps, muslo anterior y pierna medial) y la cinta Sanny© para los perímetros (brazo relajado, muslo medio y pierna). El tratamiento para la estimación del porcentaje de grasa (%G) y de masa muscular (%MM) se ejecutó bajo el protocolo del GREC y procesados mediante el SPSS 24.0. Los resultados apuntan hacia la existencia de diferencias significativas ($p<0,05$) entre sexos para el %G y el %MM. Para el desarrollo del perfil se utilizó la metodología de curvas suavizadas con la aplicación del software LMS Chart Maker© y generar puntos de corte para los percentiles 3, 10, 75, 90 y 97. Se concluye, que la clasificación para la composición corporal propuesta, sin pretender ser una norma única para establecer la tipificación del estatus de la composición corporal de un patinador, permite distinguir y categorizar con rigurosidad y objetividad, las características de la composición corporal de los patinadores independientemente de la edad y nivel competitivo. Se recomienda al presente trabajo como punto de partida a futuros estudios en poblaciones más amplias, con muestreo probabilístico y origen étnico establecido.

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Introduction

As one of the 11 sports disciplines of the World Skating Federation, World Skate[1], inline speed skating has experienced a considerable boom over the last decade with an ever-increasing number of skaters. As a result, the competitive level has evolved constantly in all continents and, with the exception of Africa, the other four continents all have countries that have successfully competed in world championships. In Europe, particular mention should be made of countries such as Italy, France, Germany, Holland, Belgium, Switzerland and Spain. In Asia: South Korea, Chinese Taipei. In Oceania: Australia, New Zealand. In North and Central America: USA, Mexico and Guatemala and South America with Argentina, Chile, Ecuador and Venezuela.

This increase in competitive performance requires the correct monitoring and control of the morphological development of athletes, given that this helps to ensure athletic longevity, and the gradual increase and stability of their performance. Anthropometric monitoring is among the controls to be made on athletes and it represents an important tool in the world of sport, making it possible to determine the morphological characteristics of the subjects. Anthropometric measurements can serve as markers of adiposity, or the distribution of fat[2], as well as indicators of robustness in relation to the ideal muscle mass for athletic performance.

However, with regard to sport, the achievement of objectives depends on a number of related factors, studied through applied sports sciences. In the case of Inline Speed Skating (ISS), mention could be made of the anthropometrics that have been studied in order to characterise this population and optimise methodological decision-making in training and physical preparation[3–8]. Given that an adequate shape and body composition represent morphological optimisation[9], this is expressed in the improved performance achieved by athletes dependant upon a representative model of success in their sports speciality.

In the case of young athletes, the anthropometric variables are considered to be a factor that interacts with performance[10]. These variables therefore need to be monitored in order to identify changes related to sports training. Body composition can be monitored by the somatotype of young athletes6, as well as the measurement of adipose skinfolds[11,12], skinfolds by site or by upper and lower body[13,14] and the percentage of fat and muscle mass[15]. Due to its aforementioned qualities, Body Composition (BC) is considered to be a control element of the training load[16].

In the athletic population, the analysis of BC is often made through the percentage of fat mass, by competition category[17,18], as well as by age[19] and muscle mass[20], including ISS from the lower categories[5,21,22] up to high performance[14,23–25]. These values of the BC components can affect the result and athletic performance.

In this regard, the characterisation of a variable by percentile curves makes it possible to observe the behaviour of the population according to age. Considering the gap in the research literature relating to the characterisation of the BC profile with normative criteria for fat mass and muscle mass in sport in general and in speed skating in particular, trainers and professionals involved in the biomedical monitoring of ISS training need to be able to interpret the BC results with a greater probability of making the right diagnosis and subsequent training programme. Therefore, the objective of this study is to determine the BC profile of young inline speed skaters who are members of the official clubs in Colombia and Venezuela.

Material and method

Design and participants

This is a descriptive study with a field investigation design, conducted within a quantitative paradigm. A longitudinal study was made of 516 athletes practising ISS, whose core variables are given in Table 1. The athletes were skaters and members of one of four (4) clubs in Colombia and two (2) in Venezuela, with sports experience of one (1) to five (5) years at national and international levels and with a training frequency of three (3) to five (5) days a week, depending on the organisation of each club and category.

The inclusion criteria were as follows: - be an athlete practising ISS, physically healthy at the time of the study; - have a systematisation of training of at least 1 month prior to each assessment; - record of participation in a regional, national or international event over the last year prior to each assessment. The exclusion criteria were as follows: - exhibit physical impediments to practising sport during the last month; - no basic command of skating skills; - be ill or suffer from some type of sports injury at the time of the assessments.

Procedure

For the Anthropometric data collection, the standards proposed by the International Society for the Advancement of Kinanthropometry

Table 1 Descriptive statistics of the basic variables of inline speed skaters according to sex.

Sex	Variables	n	Mean	SD	Min.	Max.
Female	Decimal age (years)	361	10.6	3.3	4.2	18
	Body mass (kg)	361	35.8	12.9	14.9	69
	Height (cm)	361	139.6	17.5	101	182.3
Male	Decimal age (years)	155	13.3	4.3	5.2	22.9
	Body mass (kg)	155	46.6	17	16	75
	Height (cm)	155	153.6	20.7	102.6	185.2

(ISAK) were applied with the measurements of: body mass (kg), height (cm), skinfolds (triceps, anterior thigh, medial leg) using the skinfold callipers of the Holtain© brand (0.2 mm) and circumferences (relaxed arm, mid-thigh and leg) using the anthropometric tape of the Sanny brand (0.1 cm). For the assessment of the body composition, the study followed the methodology proposed by the Spanish Group of Kinanthropometry (GREC)[15], applying regression equations to estimate percentage fat [26] and muscle mass percentage[27].

The data were collected over an 8-year timespan (from 2011 to 2018) during the kinanthropometric assessment and training control processes programmed for each club on either an annual or six-monthly basis, considering two (2) or more assessments per subject in an interval of more than four (4) months. The tests were conducted by two (2) ISAK level-2 certified anthropometrists. The ethics committee of the Observatory of Research in Sciences of Physical Activity and Sport (OI-CAFD) gave its approval to conduct the study and to use the software tool to make the calculations. Prior to each assessment, the parents or guardians of the children and young people were informed of the objective of the anthropometric test, the procedures to follow and their rights, before, during and after the assessment, in line with the Helsinki protocol, giving their written consent to participate together with their children and charges.

Statistical analysis

The SPSS v24 was used for the statistical processing of the data, with the description of the body composition for % fat (% F) and muscle mass % (% MM) with the mean, standard deviation, minimum and maximum values. The comparison of the means between sexes was performed using the Student *t*-test for independent samples. The percentile curves were plotted using the LMS method, making it possible to plot the percentile reference curves, showing the distribution of a measurement and its changes according to some co-variable, in this case age.

Moreover, this method summarises the distribution changes for three (3) curves, representing Assymetry (L), the Median (M) and the Coefficient of Variation (S), where L is expressed as a Box-Cox power[28], whose transformation adapts the distribution of the collected data to a normal distribution, minimising the effects of asymmetry[29]. The method was applied using the LMS Chart Maker software©[30].

Results

The descriptive values of the core variables for the study group are shown in Table 1. The test of normality was made for the body composition variables, indicating that these variables fit the normal curve. Parametric tests were then conducted (student t-test) to compare the means (Tables 2 and 3).

The descriptive statistics for %F are shown in Table 2 and for %MM in Table 3. With regard to %F, the female group had lower values than the male group, with significant differences ($p<0.05$) for those aged 9 and from 12 to 17 years. For its part, the male group showed significant greater values ($p<0.05$) for %MM in relation to the female group.

Table 4 gives the LMS values, respectively, for the %F by sex as well as the 3, 10, 25, 50, 75, 90 and 95 Percentile values by age. It can be highlighted that the males have a lower %F for P3 (♂=6.0; ♀=10.7) however, for P97 the value for the males is higher than for the females (♂=30.6; ♀=26.3). Proportionally, the difference for P90 changes from 7% less in females at 5 years, to 31.3% greater at 13 years and 42.8% greater at 17 years.

Table 2. Descriptive statistics and means comparison of %F for inline speed skaters according to sex.

Age	Female					Male					Means comparison	
	n	Mean	SD	min.	max	n	Mean	SD	min.	max	t-value	p
4	6	15.37	3.42	12.4	21.0							
5	23	16.30	4.11	11.8	26.5	5	15.42	5.63	11.3	25.3	-0.4	0.689
6	27	16.74	3.21	11.2	23.4	5	14.38	5.70	6.9	21.6	-1.3	0.192
7	32	16.79	6.25	10.6	35.6	11	14.25	6.65	7.6	28.2	-1.1	0.259
8	40	17.14	4.72	10.0	28.3	7	14.46	5.53	9.8	26.7	-1.4	0.183
9	43	19.19	5.73	10.0	39.3	12	14.41	4.68	8.4	22.3	-2.7	0.011
10	31	18.80	4.17	11.2	27.1	13	16.11	7.34	8.4	30.4	-1.5	0.130
11	36	19.46	5.77	10.6	39.9	10	15.54	4.02	9.1	24.5	-2.0	0.051
12	34	23.26	5.63	10.6	38.7	3	12.90	0.56	12.4	13.5	-3.1	0.003
13	22	19.97	4.26	14.3	31.9	16	13.88	3.32	8.4	18.6	-4.8	0.000
14	28	20.81	5.27	13.6	35.6	14	13.43	5.83	6.9	26.0	-4.1	0.000
15	20	21.18	3.94	9.4	25.8	20	11.71	2.28	8.4	17.5	-9.3	0.000
16	9	21.52	4.48	16.7	32.6	11	12.71	1.19	10.6	14.2	-6.3	0.000
17	10	22.00	5.03	16.1	28.9	7	11.31	1.13	9.8	12.8	-5.5	0.000
18						7	10.06	3.81	6.9	17.2		
19						3	14.00	4.87	8.4	17.2		
20						1	15.70		15.7	15.7		
21						3	8.60	1.11	7.6	9.8		
22						7	6.14	1.85	3.9	9.1		

Table 3. Descriptive statistics and means comparison of %MM for inline speed skaters according to sex.

Age	Female					Male					Means comparison	
	n	Mean	SD	Min.	Max.	n	Mean	SD	Min.	Max.	Value of t	p
4	6	33.2	2.6	29.6	36.8							
5	23	34.3	2.1	30.3	37.7	5	46.4	3.4	42.3	50.2	10.6	*0.000
6	27	35.5	2.3	31.7	40.0	5	47.2	1.1	45.6	48.4	10.9	*0.000
7	32	36.0	1.8	32.0	39.8	11	45.0	3.0	38.8	48.7	12.1	*0.000
8	40	37.3	2.1	32.6	42.9	7	46.5	1.2	45.3	48.1	10.9	*0.000
9	43	37.7	3.3	25.1	47.2	12	45.9	1.6	42.8	48.3	8.2	*0.000
10	31	38.9	3.9	34.7	56.9	13	47.3	2.7	43.8	55.0	7.0	*0.000
11	36	38.9	2.3	34.9	45.5	10	45.8	3.2	41.2	50.9	7.6	*0.000
12	34	38.2	2.1	33.9	41.8	3	43.7	0.3	43.4	44.0	4.5	*0.000
13	22	38.5	2.1	35.5	42.6	16	45.8	1.7	42.2	48.6	11.3	*0.000
14	28	40.1	2.7	36.1	47.0	14	45.0	2.4	39.4	49.6	5.9	*0.000
15	20	39.9	2.7	31.6	43.3	20	46.1	2.0	41.5	50.2	8.4	*0.000
16	9	40.0	2.4	36.6	44.4	11	46.1	2.3	39.8	48.4	5.8	*0.000
17	10	40.9	2.0	37.2	43.9	7	47.1	1.5	44.6	49.4	6.8	*0.000
18						7	47.0	3.0	42.6	49.5		
19						3	49.5	1.5	47.9	50.7		
20						1	49.3		49.3	49.3		
21						3	47.7	2.3	45.2	49.8		
22						7	42.8	7.0	27.4	48.3		

*Significant differences at 0.05.

Likewise, Table 5 gives the values for LMS for %MM by sex and the P values from 3 to 97, as described above. Comparing the sexes in all the percentile values and ages, the males have greater values than the females. This proportion decreases in percentage terms with age. So that, at 5 years, the P90 for males indicates 34% more %MM than the females, while this difference is 15% at 13 years and 13% at 18 years. However, irrespective of sex, the groups show an increase with age.

Figures 1 and 2 show the smoothed LMS curves for %F, observing how this increases with age for females and decreases for males. For females, the %MM shows a more pronounced increase with age (Figure 3) while the %MM for males shows a moderate increase with age for skaters (Figure 4).

Discussion

This study was directed at determining the BC profile of young ISS. So, firstly, a comparison of means between sexes was made for %F and %MM, finding significant differences ($p<0.05$) for %F at 9 years and from 12 years onwards. While, for %MM, there were significant differences ($p<0.05$) between sexes irrespective of age. The classification by body composition curves was then made (%F and %MM), taking five (5) cut-off points in accordance with the percentile points of the smoothed LMS curves and assuming the following classification: less than P3: Very low; up to P10: Low; up to P75 Normal; up to P90: High and P97 and above: Very high. Therefore, the findings of this study make it possible to establish a body composition profile with the classification for %F and %MM in both sexes, with ages ranging from 4 to 18 years for females and from 5 to 22 years for males.

It was found that, when compared to this study, European male long-distance skaters are located at P75 of the curves for %F and

**Figure 1. Smoothed percentile curves for %fat for female inline speed skaters.**
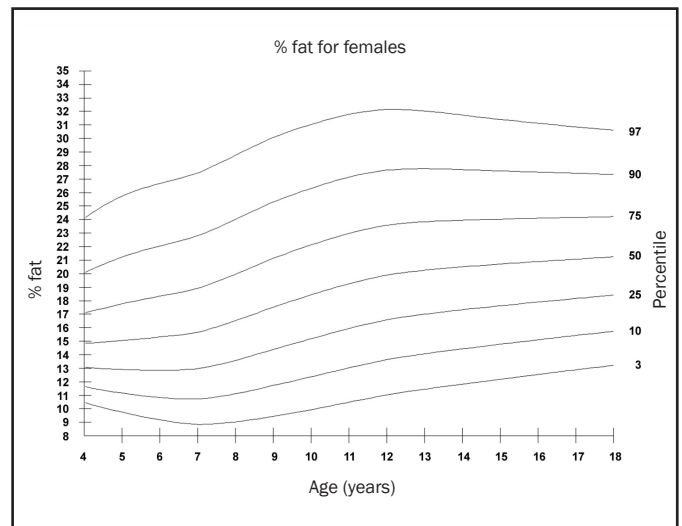
short-distance skaters at P90; these values are high given that it is competition time and they are in the top 8 of the 2009 European championships[7]. In a study on women skaters in the Valle del Cauca league selection, with a mean age of 18 years, the mean fat was found to be 15.8%[31]. When compared to this study, it was placed at P10, which is normal for the proposed classification.

Another study on young skaters in Bogota, aged between 11 to 13 years, showed a mean % fat of 15.99% and, for the group aged 14 to 16 years, a mean % fat of 22.5%[23], locating both values in the normal area of the proposed classification, specifically between P10 and P75. Likewise, for 12-year-old girls competing at a national level, mean fat

Table 4. LMS values and percentile points of the %F by sex for inline speed skaters.

Age	L	M	S	3	10	25	50	75	90	97
Female										
4	-1.491	14.531	0.197	10.7	11.6	12.9	14.5	16.8	20.3	26.3
5	-1.172	14.886	0.224	10.4	11.5	13.0	14.9	17.5	21.5	28.1
6	-0.924	15.112	0.244	10.1	11.4	13.0	15.1	18.0	22.3	28.9
7	-0.726	15.303	0.258	9.9	11.3	13.0	15.3	18.4	22.7	29.2
8	-0.544	16.124	0.265	10.1	11.7	13.6	16.1	19.4	23.9	30.1
9	-0.371	17.233	0.266	10.6	12.3	14.5	17.2	20.7	25.2	31.2
10	-0.201	18.242	0.264	11.0	13.0	15.3	18.2	21.8	26.3	31.9
11	-0.042	19.119	0.259	11.4	13.6	16.1	19.1	22.7	27.1	32.3
12	0.111	19.804	0.253	11.8	14.0	16.7	19.8	23.4	27.6	32.4
13	0.261	20.200	0.246	11.9	14.3	17.1	20.2	23.7	27.7	32.1
14	0.406	20.465	0.239	12.0	14.6	17.4	20.5	23.9	27.6	31.7
15	0.542	20.694	0.231	12.1	14.8	17.6	20.7	24.0	27.5	31.3
16	0.665	20.911	0.224	12.3	15.0	17.9	20.9	24.1	27.5	31.0
17	0.779	21.114	0.218	12.4	15.2	18.1	21.1	24.2	27.4	30.7
Male										
5	-0.060	13.271	0.407	6.0	7.8	10.1	13.3	17.5	23.1	30.6
6	-0.160	12.809	0.388	6.2	7.8	9.9	12.8	16.7	22.0	29.4
7	-0.252	12.763	0.369	6.5	8.0	10.1	12.8	16.5	21.6	28.9
8	-0.319	13.070	0.350	6.9	8.5	10.4	13.1	16.7	21.7	28.9
9	-0.356	13.430	0.333	7.4	8.9	10.8	13.4	16.9	21.8	28.7
10	-0.367	13.627	0.318	7.7	9.2	11.1	13.6	17.0	21.6	28.1
11	-0.358	13.531	0.305	7.8	9.3	11.1	13.5	16.7	21.0	26.9
12	-0.338	13.146	0.295	7.7	9.1	10.9	13.1	16.1	20.1	25.4
13	-0.313	12.621	0.288	7.4	8.8	10.5	12.6	15.4	19.0	23.8
14	-0.287	12.075	0.284	7.1	8.4	10.0	12.1	14.7	18.0	22.5
15	-0.261	11.594	0.282	6.9	8.1	9.7	11.6	14.1	17.2	21.3
16	-0.233	11.126	0.282	6.5	7.8	9.3	11.1	13.5	16.5	20.4
17	-0.204	10.551	0.286	6.1	7.3	8.8	10.6	12.8	15.7	19.4
18	-0.174	9.854	0.291	5.7	6.8	8.1	9.9	12.0	14.7	18.2
19	-0.140	9.044	0.297	5.1	6.2	7.4	9.0	11.1	13.6	16.8
20	-0.104	8.102	0.303	4.5	5.5	6.6	8.1	9.9	12.2	15.2
21	-0.067	7.063	0.309	3.9	4.7	5.8	7.1	8.7	10.7	13.3
22	-0.030	5.996	0.315	3.2	3.9	4.9	6.0	7.4	9.2	11.3

Figure 2. Smoothed percentile curves for %fat for male inline speed skaters.
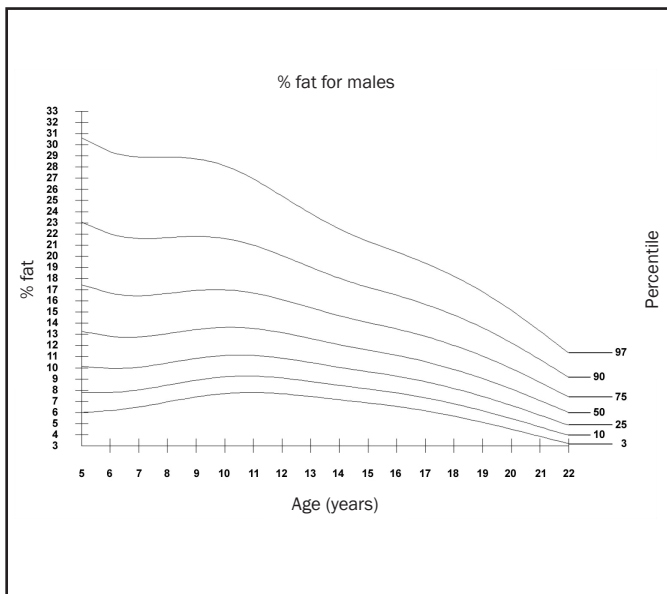
values of 12.2% were found[21]. Along these same lines, 13-year-old male and female skaters were found to have 10% and 19% fat respectively[5]. All the values mentioned above are located in the normal area for this current proposal.

However, when making the analysis with regard to competitive level, it can be seen that the speed skaters in the National Games of Venezuela 2005 exhibited a %F of 18.6% for males and 17.3% for females, while long-distance skaters had 19.7% for males and 19.2% for females[4]. On the other hand, skaters from the Colombian department of Norte de Santander, taking part in the national games of 2012 exhibited a percentage fat of 18.8% for females and 10.8% for males[24]. However, when comparing competitive performance, it was observed that youth medallists (mean age of 17 years) had 7.8% fat compared to non-medallists with 9.8% fat. The above indicates that the fat values closer to the lower area (under P10) are an indicator of a probable improvement in the skater's performance, making the caveat that any extremely low values (under P3) are not at all beneficial to the athlete's health.

With regard to the %MM as an indicator of the skater's BC, studies with national level skaters have reported values of 44.9% for females and

Table 5. LMS values and percentile values for the %MM by sex for inline speed skaters.

Age	L	M	S	3	10	25	50	75	90	97
Female										
4	0.408	32.597	0.064	28.6	29.9	31.2	32.6	34.0	35.5	36.9
5	-0.119	33.796	0.062	29.9	31.1	32.4	33.8	35.2	36.7	38.3
6	-0.480	34.812	0.061	30.9	32.1	33.4	34.8	36.3	37.8	39.5
7	-0.619	35.744	0.061	31.8	33.0	34.3	35.7	37.2	38.8	40.5
8	-0.637	36.618	0.061	32.6	33.8	35.2	36.6	38.2	39.8	41.5
9	-0.603	37.263	0.061	33.1	34.4	35.8	37.3	38.8	40.5	42.3
10	-0.503	37.677	0.061	33.5	34.8	36.2	37.7	39.3	40.9	42.7
11	-0.309	37.953	0.061	33.7	35.0	36.4	38.0	39.5	41.2	43.0
12	-0.032	38.199	0.061	33.8	35.2	36.7	38.2	39.8	41.4	43.2
13	0.298	38.535	0.061	34.0	35.5	37.0	38.5	40.1	41.8	43.4
14	0.677	38.942	0.061	34.3	35.8	37.4	38.9	40.5	42.2	43.8
15	1.087	39.352	0.061	34.5	36.1	37.7	39.4	40.9	42.5	44.1
16	1.482	39.749	0.061	34.8	36.5	38.1	39.7	41.3	42.9	44.5
17	1.856	40.135	0.061	35.0	36.8	38.5	40.1	41.7	43.3	44.8
18	2.210	40.506	0.060	35.2	37.1	38.8	40.5	42.1	43.6	45.1
Male										
5	9.334	47.029	0.046	38.2	43.0	45.4	47.0	48.3	49.4	50.3
6	8.773	46.227	0.044	39.2	42.6	44.7	46.2	47.4	48.4	49.3
7	8.038	45.791	0.042	39.8	42.5	44.4	45.8	47.0	48.0	48.8
8	7.118	45.692	0.042	40.3	42.6	44.3	45.7	46.9	47.9	48.8
9	6.233	45.713	0.042	40.6	42.7	44.3	45.7	46.9	48.0	48.9
10	5.516	45.715	0.042	40.8	42.7	44.3	45.7	46.9	48.0	49.0
11	5.020	45.601	0.043	40.7	42.6	44.2	45.6	46.8	48.0	49.0
12	4.758	45.443	0.044	40.6	42.4	44.0	45.4	46.7	47.8	48.9
13	4.673	45.388	0.044	40.5	42.4	44.0	45.4	46.7	47.8	48.9
14	4.695	45.487	0.045	40.5	42.4	44.1	45.5	46.8	47.9	49.0
15	4.762	45.713	0.045	40.6	42.6	44.3	45.7	47.0	48.2	49.3
16	4.835	45.996	0.046	40.8	42.8	44.5	46.0	47.3	48.5	49.6
17	4.882	46.284	0.046	40.9	43.0	44.8	46.3	47.6	48.8	50.0
18	4.903	46.530	0.047	41.0	43.2	45.0	46.5	47.9	49.1	50.3
19	4.904	46.705	0.047	41.1	43.3	45.1	46.7	48.1	49.3	50.5
20	4.894	46.806	0.048	41.1	43.3	45.2	46.8	48.2	49.5	50.6
21	4.877	46.858	0.048	41.1	43.4	45.2	46.9	48.3	49.6	50.7
22	4.858	46.885	0.049	41.0	43.3	45.2	46.9	48.3	49.6	50.8

Figure 3. Smoothed percentile curves for % muscle mass for female inline speed skaters.
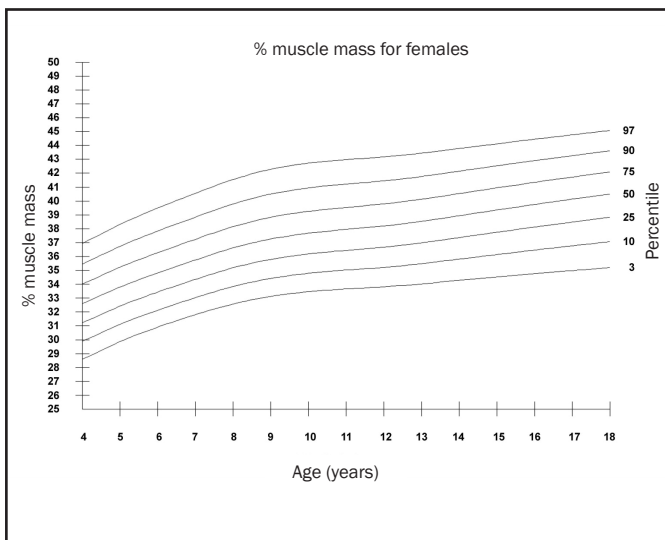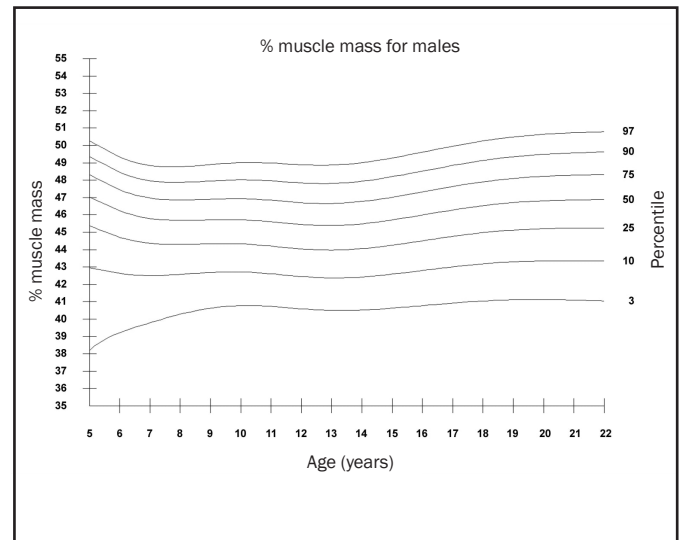

Figure 4. Smoothed percentile curves for % muscle mass for male inline speed skaters.

48.2% for males[24]. 12-year-old boys have been reported to have 45.5% and girls 44.1%[5] while values of 49.9% were found in 12-year-old boys in Neiva-Colombia[22]. On analysing these values, based on competitive performance, the young male medallists had 48.4% while non-medallists had 48.3%[14]. It can be seen that the values indicated are located between P10 and P90 of this study.

Taking the findings into account and the fact that the proposal presented is not intended to be a unique rule to characterise the BC of a skater, it is appropriate to consider that the classification presented makes it possible to identify and to precisely and objectively classify the BC characteristics of skaters irrespective of age and competitive level. By considering the interpretation in accordance with the time of training, whether at the start of preparation or close to a competition, this tool is equally useful in the biomedical, nutritional or physiological diagnosis, as it is compared with other variables such as maturity, growth, age, competitive level, performance, training and functional aspects.

It is important to point out that, irrespective of the formula used, the personnel involved in the monitoring and control of the training frequently handle body composition references that are from studies with focal populations (with regard to age, sex, competitive level or training time), even for other sports or from overweight prediction models in multi-sport groups[32] for the purpose of comparing and establishing a diagnosis and deciding on the appropriate training programme. Therefore, some of the strengths of this study include the number of longitudinally-assessed subjects, the age range assessed, all are skaters from official clubs within their federations, and the data were directly collected by the author, together with qualified assessors having extensive experience in the handling of anthropometric assessments with large populations.

Finally, it is argued that one of the major limitations lies in the non-probabilistic sample. However, this study can be considered to be a starting point for future studies on larger populations, with probabilistic sampling and considering their ethnic origin. It would also be possible to classify the gross value of skinfolds and circumferences to make it easier for biomedical personnel (sports doctors and nutritionists) as well as exercise physiologists to interpret the anthropometric data.

Conclusions

The values found in this study are in line with the evidence available in the literature. Thus, the classification presented, without aiming to establish the population parameters, makes it possible to identify and to precisely and objectively classify the BC characteristics of skaters irrespective of age and competitive level. Therefore, any interpretation resulting from the comparison with this present proposal is left to the discretion of the professional using it, as considered advisable for the subjects being assessed.

Conflict of interest

The authors have no conflict of interest at all.

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