EATING DISORDERS IN SPANISH ACROBATIC GYMNASTS BASED ON SEX AND COMPETITIVE LEVEL

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Abstract

The aim of this study was to assess the body composition and the risk of developing an eating disorder (ED) in two groups of Spanish elite acrobatic gymnasts. A cross-sectional descriptive study was conducted, where 130 acrobatic gymnasts aged 9 to 21 and registered with the Spanish federation voluntarily participated; 56 of them were competing at the international level and 74 at the national level. Height and weight measures were used to calculate body mass index (BMI) and skinfolds were measured to determine the percentage of body fat. The Eating Disorders Inventory (EDI-3-RF) was applied to assess the ED variables. The results revealed that most gymnasts presented normal weight (BMI) and a low % body fat, and the international-level gymnasts showed lower values than national-level ones. However, *52.6% of the gymnasts in this study were at risk of developing an ED. Concerning the scales, the scores related to drive for thinness were noteworthy, especially in women competing at the international level, who reported greater concern about weight and body image. The international-level gymnasts met most of the referring criteria; in particular, most senior gymnasts met criterion 3. There was an average percentage of gymnasts at risk of developing an ED. The risk factors were more noticeable among female international-level gymnasts who presented greater drive for thinness and body dissatisfaction.*

Keywords: *gymnastics, acrobatic gymnastics, eating disorder, anthropometry.*

INTRODUCTION

Acrobatic gymnastics (AcG) was included in the International Gymnastics Federation (FIG) in 1999. It is based on regulated behaviours and, like in the rest of gymnastic disciplines, exercises are artful and composed of multiple independent

skills or elements, performed in stardardised and stable spaces, and regulated by the Code of Points (COP) which defines this modality (Vernetta & López-Bedoya, 2005).

In aesthetic sports, including AcG, high technical complexity combined with some components of physical fitness (including strength, flexibility, speed, coordination and balance), and a good body image (BI) are some determining factors that can lead to sports success (Peláez & Vernetta, 2018). Certain anthropometric measures, such as weight, BMI and percentage of body fat, become important in relation to this BI, as well as the selection process that determines the roles to be performed in this sport: base or top (Taboada-Iglesias et al., 2017; Taboada-Iglesias et al., 2021). For obvious reasons, depending on the motor profile of this discipline, smaller, younger gymnasts with less body weight act as tops gymnasts occupying the upper part of the collective figures and pyramids, performing elements of flexibility, balance and combinations on top of the bases, or large acrobatic jumps in the aerial phase by means of propulsion of the bases in order to land on them or on the floor (Vernetta & López-Bedoya, 2005; Salas-Morillas et al., 2022). Hence, depending on the position or the role played by the gymnast, their morphological characteristics are specific and different, with the bases being heavier and larger, presenting an endo-mesomorphic somatotype, while the tops are smaller in size, weight and percentage of body fat with an ectomorphic tendency (Taboada-Iglesias et al., 2016; Salas-Morillas, et al., 2022).

Excessive concern regarding weight or BI can lead to eating disorders. This can have negative effects on the gymnast's performance and, more importantly, a negative impact on health.

Eating disorders (EDs) are characterised by abnormal eating behaviours, such as trying to control weight, based on a psychological disorder. These EDs are serious mental health issues that mainly affect young women; they are usually chronic severe disorders associated with high dysfunctionality (Dallas et al., 2016; Dallas et al., 2017; Fernández-Rivas, 2021; Herpertz-Dahlmann, 2009). The most frequent ED syndromes are anorexia nervosa (AN), bulimia nervosa (BN) and eating disorders not otherwise specified (ED-NOS), according to the fifth review of the *Diagnostic and statistical manual of mental disorders* (DSM-5) by the American Psychiatric Association (APA, 2013).

There is scientific evidence that most experienced female artistic and rhythmic gymnasts restrict their food intake to stay thin and maintain pubertal looks (Deutz et al., 2000; Jonnalaggada & Benardot, 2000; Papacharalampous et al., 2022). On the other hand, Nordin et al. (2003) assessed EDs in gymnasts who presented normal eating behaviours associated with hypocaloric and reduced nutrient intake. However, they observed that not most of artistic gymnasts were at risk of developing nutritional disorders (Papacharalampous et al., 2022). By contrast, most rhythmic and aerobic gymnasts could be considered at risk of developing an eating disorder (Donti et al., 2021; Jardim et al., 2022; Valles et al., 2020).

Most studies so far have looked at artistic and rhythmic gymnastics, and very few focused on AcGs. That is why our aim was to assess the risk of developing an ED and body composition in Spanish acrobatic

gymnasts based on sex and competitive level.

METHODS

This was a descriptive, cross-sectional, non-experimental study in which 130 acrobatic gymnasts (17 male, 113 female) registered with the Spanish Federation and aged between 9 and 21 (14.14±3.30) volunteered to participate. The participants had at least 4 years (6.18±2.62) of training experience and trained 8-10h/week (13.8%) or more than 10h/week (86.2%). The participants were classified into two groups according to their competitive level: international level (FIG) or national level (RFEG). The RFEG group of gymnasts consisted of 71 women (age= 12.59±1.95 years) and 3 men (age= 14±0 years) with an average training time of 12.32±2.98h per week. The FIG group consisted of 42 women (age= 15.34±2.91 years), and 14 men (age= 18.5±4.75 years) with an average training time of 14.69±6.63h per week.

All procedures applied in this study were approved by the Ethics Committee of the University of Granada (Reference number: 1484/CEIH/2020). The study complied with all ethical research principles outlined in the Declaration of Helsinki.

The Spanish adaptation (Elosua et al., 2010) of the *Eating Disorders Inventory* (EDI-3-RF) (Garner, 2004) was used to assess EDs. It allows for quick assessment through standardised criteria in order to discard or confirm the presence of an ED. An individual score can be obtained from each of the three scales: Drive for Thinness (composed of 7 items), Bulimia (8 items) and Body Dissatisfaction (10 items), as well as a total score by adding up the 25 items:

* Drive for Thinness scale (DT) measures a strong drive for getting thinner or a strong fear of fatness, consequently becoming a good predictor of binge eating or ED development. The direct score ranges from 0 to 20, 12 being the critical value (García et al., 2012).

* Bulimia scale (B) evaluates the tendency towards thoughts related to excessive eating or towards uncontrolled binge eating. The direct score ranges from 0 to 32, the critical value lying between 5 and 8, depending on the gymnast's BMI (García et al., 2012).

* Body Dissatisfaction scale (BD) assesses the individual's dissatisfaction with their general body shape or those body parts about which people with ED are usually most concerned: belly, hips, thighs, buttocks, etc. The direct score ranges from 0 to 40, divided into three levels depending on the body dissatisfaction intensity: 0-6 low, 7-27 average and 28-40 high (García et al., 2012).

Lastly, this questionnaire allows for referral to a specialised service, depending on three standard criteria:

- Criterion 1 is exclusively based on the individual's BMI. Depending on sex and age, it is decided whether the body weight is excessively low.
- Criterion 2 relates BMI to the presence of excessive concern about weight or food, or complicated eating patterns (assessed through DT and B scales).
- Criterion 3 focuses on the presence of behavioural symptoms that could suggest an ED (assessed through the B scale of the questionnaire).

The following instruments were used to measure the anthropometric variables: TEFAL digital scales for body mass, with 0.05kg accuracy; SECA 220 stadiometer for height, 1mm accuracy; and a plicometer for

skinfolds (triceps [TS], biceps [BS], subscapular [SSS], suprailiac [SIS], abdominal [AS] and medial calf [MCS]). BMI was calculated by dividing weight in kilograms by height in metres squared. Two different equations using the measured skinfolds were applied to calculate the percentage of body fat. Firstly, considering that lower-limb measurements are essential due to their high importance in the motor function of children and adolescents when practising gymnastics (Taboada-Iglesias et al., 2017), the equation proposed by Slaughter et al. (1988) was applied using the addition of the triceps and medial calf skinfolds. Subsequently, the formula suggested by Yuhasz (1974) was applied, which used the addition of six skinfolds (TS, BS, SSS, SIS, AS, MCS). This one is specially indicated for high-performance athletes and highly trained individuals.

For gymnasts under 18 years old, the cut-offs proposed by Cole et al. (2007) were used: thinness grade 3 (<16), thinness grade 2 (16.1-17), thinness grade 1 (17.1-18.5), normal weight (18.5-24.9), overweight (25-30) and obesity (≥30). For the 10 gymnasts aged 19 to 21, the WHO criteria were followed: underweight (<18.5), normal weight (18.5-24.9), overweight (25-29.9), obesity grade 1 (30-34.9), obesity grade 2 (35-39.9), obesity grade 3 (>40).

All Spanish clubs were visited. Firstly, a self-registration form was distributed to collect the participants' age, years of AcG practice, club, competitive level, training days and hours/week. Secondly, they were requested to fill in the EDI-3-RF. Lastly, the anthropometric measurements were conducted following the recommendations and protocol established by the International Society for the Advancement of Kinanthropometry (ISAK) (Marfell-Jones et al., 2006). The anthropometric assessment was carried out by ISAK level 1-certified staff following this order: weight, height, and triceps, biceps, subscapular, suprailiac, abdominal and medial calf skinfolds of all participants. During the measurements, all gymnasts were barefoot and wearing training clothes.

A descriptive study of the data was carried out, using an analysis based on contingency tables, observing the independence of the data using Pearson's chi-square statistic.

Given the small size of some of the groups formed, once the sample was distributed according to the levels of the variables Level of competition and Sex, we opted for a non-parametric analysis.

Correlation analysis was approached by calculating Spearman's correlation coefficient.

Differences were considered statistically significant for p-values < .05. Data are shown as observed frequencies and percentages, except for quantitative variables, in which case they are shown as mean values and standard deviation.

The Statistical Package for the Social Sciences (SPSS) v.25.0 (SPSS Inc., Chicago, IL) was used to conduct the statistical analyses.

RESULTS

Descriptive statistics of arthrometric variables are presented in Table 1.

Table 2 shows BMI considering the cut-offs proposed by Cole et al. (2007) for gymnasts under 18.

For the remaining 10 gymnasts aged 18 to 21 years, the criteria of the World Health Organisation (OMS, 2023) were used for the BMI weight classification. 70% presented normal weight and of the remaining athletes, 20% of the women were

overweight (compared to 10% of the men). None were obese or underweight.

Table 3 contains the number and percentage of gymnasts who presented critical values according to the different scales: Drive for Thinness (DT) and Bulimia (B).

Table 4 shows the frequency and percentage of body dissatisfaction levels according to EDI-3-RF, divided by sex and competitive level.

Table 5 shows the frequency and percentage of individuals who were referred to treatment according to the three criteria established by EDI-3-RF.

An analysis based on contingency tables was conducted controlling for the effect of the variables 'Competitive level' and 'Sex' (Table 6) with the purpose of further examining the dependent variables based on the categories. In male, international-level gymnasts, the age group was related to the variables 'drive for thinness' and 'body dissatisfaction' measured through EDI-3-RF ($\chi^2(8, N = 9) = 18.000$, $p = .021$), with moderate ($\eta = .407$) and high ($\eta = .900$) effect sizes, respectively.

Table 1:
Descriptive variable values based on sex and competitive level.

	FIG			***RFEG***			***TOTAL***		
	M (n=14)	*W (n=42)*	*T (n=56)*	*M (n=3)*	*W (n=71)*	*T (n=74)*	*M (n=17)*	*W (n=113)*	*T (N=130)*
Weight (kg)	66.03± 20.87	49.47± 11.68	53.61± 16.03	60.00± 2.74	44.30± 11.04	44.94± 11.26	64.96± 18.99	46.22± 11.51	48.67± 14.14
Height (m)	1.67± 0.16	1.57± 0.09	1.60± 0.12	1.69± 0.03	1.50± 0.11	1.50± 0.11	1.68± 0.14	1.52± 0.11	1.54± 0.12
BMI	22.82± 3.93	19.71± 2.99	20.49± 3.49	21.08± 0.17	19.44± 2.78	19.51± 2.75	22.51± 3.61	19.54± 2.85	19.93± 3.11
MCS	11.89± 3.69	12.40± 3.20	12.28± 3.31	9.00± 1.00	12.05± 3.30	11.93± 3.29	11.38± 3.53	12.18± 3.26	12.08± 3.29
TS	11.46± 3.90	11.51± 3.97	11.50± 3.92	9.83± 0.76	11.58± 3.48	11.51± 3.43	11.18± 3.58	11.56± 3.65	11.51± 3.63
BS	8.00± 3.04	8.38± 2.79	8.29± 2.83	7.33± 0.58	8.37± 2.63	8,32± 2.59	7.88± 2.76	8.37± 2.68	8.31± 2.68
SSS	12.11± 2.68	10.60± 4.92	10.97± 4.49	9.17± 2.25	10.42± 4.37	10.36± 4.31	11.59± 2.80	10.48± 4.56	10.63± 4.38
SIS	12.29± 2.92	11.31± 4.49	11.55± 4.15	9.67± 1.53	11.06± 4.09	11.00± 4,03	11.82± 2.88	11.15± 4.23	11.24± 4.07
AS	11.29± 5.47	12.38± 5.41	12.11± 5.39	8.00± 2.65	12.39± 4.97	12.22± 4.97	10.71± 5,18	12.39± 5.11	12.95± 5.00
Σ6 SKINFOLDS	58.14± 22.42	66.51± 22.91	64.42± 22.88	48.67± 14.47	67.61± 20.45	66.84± 20.52	56.47± 21.18	67.20± 21.30	66.61± 19.36
% BF Slaughter	14.10± 5.22	20.15± 4.56	18.63± 5.38	13.62± 3.33	20.78± 4.09	20,49± 4.28	14.01± 4.85	20.54± 4.26	19.78± 4.23
%BF 6 skinfolds Yuhasz	12.77± 13.19	14.07± 3.28	13.75± 7.03	8.36± 1.40	14.23± 2.92	13.99± 3.10	11.99± 12.02	14.17± 3.05	13.71± 3.08
DT	11.71± 7.49	11.05± 6.94	11.21± 7.02	10.67± 8.02	10.80± 7.75	10.80± 7.71	11.53± 7.33	10.89± 7.43	10.98± 7.39
B	6.14± 7.42	8.21± 7.22	7.70± 7.26	7.00± 6.56	6.28± 5.90	6.31± 5.88	6.29± 7.09	7.00± 6.46	6.91± 6.52
BD	16.71± 3.12	15.79± 6.62	16.02± 5.93	16.33± 4.04	17.72± 4.87	17.66± 4.82	16.65± 3.16	17.00± 5.63	16.95± 5.37

BMI= Body mass index; TS=Triceps, BS= Biceps; SSS= Subscapular; SIS= Suprailiac; AS= Abdominal; MCS= Medial calf; DT=Drive for Thinness scale; B= Bulimia scale; BD= Body Dissatisfaction scale

Table 2
Frequency (percentage) of BMI values.

COMPETITIVE LEVEL	SEX	T-1	T-2	T-3	NORM	OVER	OB
FIG	M (n=7) %	-	1 (14.3)	2 (28.6)	3 (42.9)	1 (14.3)	-
	W (n=39) %	5 (12.8)	5 (12.8)	3 (7.7)	25 (64.1)	1 (2.6)	
	T (n=46) %	5 (10.9)	6 (13.0)	5 (10.9)	28 (60.9)	2 (4.3)	-
RFEG	M (n=3) %	-	-	-	3 (100.0)	-	-
	W (n=71) %	9 (12.7)	9 (12.7)	6 (8.5)	45 (63.4)	2 (2.8)	-
	T (n=74) %	9 (12.2)	9 (12.2)	6 (8.1)	48 (64.9)	2 (2.7)	-
TOTAL	M (n=10) %	-	1 (10.0)	2 (20.0)	6 (60.0)	1 (10.0)	-
	W (n=110) %	14 (12.7)	14 (12.7)	9 (8.2)	70 (63.6)	3 (2.7)	-
	T (N=120) %	14 (11.7)	15 (12.5)	11 (9.2)	76 (63.3)	4 (3.3)	-

T-3: Thinness grade 3; T-2: Thinness grade 2; T-1: Thinness grade 1; NORM: Normal weight; OVER: Overweight; OB: Obesity.
* Depending on the competitive level for participants under 18 years old.

Table 3
Frequency (percentage)of Drive for Thinness (DT) and Bulimia (B) scales.

COMPETITIVE LEVEL	SEX	DT	B
FIG	M (n=14) %	5 (35.7)	4 (28.6)
	W (n=42) %	24 (57.1)	28 (66.7)
	T (n=56) %	29 (51.8)	32 (57.1)
RFEG	M (n=3) %	1 (33.3)	2 (66.7)
	W (n=71) %	29 (40.8)	44 (62.0)
	T (n=74) %	30 (40.54)	46 (62.2)
TOTAL	M (n=17) %	6 (35.2)	6 (35.3)
	W (n=113) %	53 (46.9)	72 (63.7)
	T (N=130) %	59 (45.38)	78 (60.0)

* Gymnasts who presented critical values according to Drive, divided by sex and competitive level.
DT=Drive for Thinness scale; B= Bulimia scale

Table 4
Frequency (percentage) of body dissatisfaction levels (EDI-3-RF).

COMPETITIVE LEVEL	SEX	LOW	MEDIUM	HIGH
FIG	M (n=14) %	5 (35.7)	9 (64.2)	-
	W (n=42) %	3 (7.1)	38 (90.4)	1 (2.3)
	T (n=56) %	8 (14.2)	47 (83.9)	1 (1.7)
RFEG	M (n=3) %	3 (100.0)	-	-
	W (n=71) %	6 (8.4)	65 (91.5)	-
	T (n=74) %	6 (8.1)	68 (91.8)	-
TOTAL	M (n=17) %	4 (23.5)	13 (76.4)	-
	W (n=113) %	9 (7.9)	103 (91.1)	1 (0.9)
	T (n=130) %	13 (10.0)	116 (89.2)	1(0.8)

***** Divided by sex and competitive level.

Table 5
Frequency (percentage) of individuals who met the referring criteria.

COMPETITIVE LEVEL	SEX	Crit 1	Crit 2	Crit 3
FIG	M (n=14) %	1 (7.1)	6 (42.9)	4 (28.6)
	W (n=42) %	3 (7.1)	33 (78.6)	9 (21.4)
	T (n=56) %	4 (7.1)	39 (69.6)	13 (23.2)
RFEG	M (n=3) %	-	1 (33.3)	-
	W (n=71) %	2 (2.8)	46 (64.7)	10 (14.1)
	T (n=74) %	2 (2.7)	47 (63.5)	10 (13.5)
TOTAL	M (n=17) %	1 (5.9)	7 (41.1)	4 (5.2)
	W (n=113) %	5 (4.4)	79 (69.9)	19 (16.8)
	T (N=130) %	6 (4.6)	92 (66.1)	23 (17.7)

***** Divided by sex and competitive level.

Table 6

Pearson's chi-squared test and coefficient of association between pairs of variables.

Variables dependientes		**FIG**			**RFEG**			**Total**		
		M	*W*	*Total*	*M*	*W*	*Total*	*M*	*W*	*Total*
DT (drive for thinness)	χ^2	18.000	82.044	72.457	19.200	56.721	70.156	41.083	92.237	95.934
	gl	8	57	60	15	69	75	27	81	84
	N	9	39	48	8	74	82	17	113	130
	p	.021	.017	.130	.205	.855	.637	.040	.185	.176
	CA	.407(c)	.241(c)	.236(c)	.487(c)	.101(c)	.120(c)	.353(c)	.152(c)	.140(c)
B (bulimia)	χ^2	18.000	54.702	71.688	16.800	71.059	75.353	42.500	68.899	76.300
	gl	10	42	54	12	63	66	27	69	75
	N	9	39	48	8	74	82	17	113	130
	p	.055	.090	.054	.157	.227	.202	.029	.481	.436
	CA	.297(c)	.095(c)	.147(c)	.451(c)	.318(c)	.250(c)	.303(c)	.185(c)	.149(c)
BD (body dissatisfaction)	χ^2	18.000	57.435	68.674	14.400	77.882	64.467	36.243	102.965	105.983
	gl	8	45	45	15	57	57	24	66	66
	N	9	39	48	8	74	82	17	113	130
	p	.021	.101	.013	.495	.495	.232	.052	.002	.001
	CA	.900(c)	.389(c)	.342(c)	.597(c)	.101(c)	.121(c)	.623(c)	.186(c)	.186(c)
Dissatisfaction in EDI 3RF	χ^2	(*)	2.273	2.369	(*)	5.189	4.864	(*)	3.999	3.491
	gl	--	3	3	--	6	6	--	6	6
	N	9	39	48	8	74	82	17	113	130
	p	--	.518	.499	--	.520	.561	--	.677	.745
	CA	(*)	.235	.217	(*)	.256	.237	(*)	.185	.162
			p = ,518	*p* = .499		*p* = .520	*p* = .561		*p* = .677	*p* = .745
Criterion 1	χ^2	.321	.975	.775	(a)	4.773	4.067	1.195	3.037	3.174
	gl	2	3	3	--	3	3	3	3	3
	N	9	39	48	8	74	82	17	113	130
	p	.852	.807	.855	--	.189	.254	.754	.386	.366
	CA	1.86(a)	.156(a)	.126(a)	(*)	.246(a)	.217(a)	.256(a)	.162(a)	.154(a)
		p =.852	*p* = .807	*p* = .855		*p* = .189	*p* = .254	*p* = .754	*p* = .386	*p* = .366
Criterion 2	χ^2	2.057	2.333	1.200	3.200	.825	1.989	1.613	2.435	1.623
	gl	2	3	3	3	3	3	3	3	3
	N	9	39	48	8	74	82	17	113	130
	p	.358	.506	.753	.362	.843	.575	.656	.487	.654
	CA	.431(a)	.238(a)	.156(a)	.534(a)	.105(a)	.154(a)	.294(a)	.145(a)	.111(a)
		p = .358	*p* = .506	*p* = .753	*p* = .362	*p* = .843	*p* = .575	*p* = .656	*p* = .487	*p* = .654
Criterion 3	χ^2	2.100	2.982	8.888	.686	2.376	1.762	3.068	2.448	5.525
	gl	2	3	3	3	3	3	3	3	3
	N	7	38	45	8	73	81	15	111	126
	p	.350	.394	.031	.877	.498	.623	,381	.485	.137
	CA	.480(a)	.270(a)	.406(a)	.281(a)	.178(a)	.146(a)	.412(a)	.147(a)	.205(a)
		p = .350	*p* = .394	*p* = .031	*p* = .877	*p* = .498	*p* = .623	*p* = .381	*p* = .485	*p* = .137

(*) The statistic has not been calculated as the variable analysed is a constant.

CA = Coefficient of association

a = Contingency ratio; b = Association coefficient Gamma; c = Association coefficient Eta

*On one side, age group, competitive level and sex and, on the other, drive for thinness, bulimia, body dissatisfaction, Dissatisfaction in EDI-3-RF and Referring criteria 1, 2 and 3.

Table 7
Correlation analysis through Spearman's Rho based on competitive level and sex.

		Sex	CL	Role	We.	He.	BMI	Σ6SF	%BF S.	%BF Y.	DT	B	BD	C1	C2	C3
Sex	CC	1.000	-.308**	0.096	.359**	.380**	.278**	0.038	-0.116	-.186*	-0.029	-0.089	-0.086	0.023	-.202*	0.059
	p		0.000	0.276	0.000	0.000	0.001	0.665	0.189	0.034	0.744	0.312	0.329	0.791	0.021	0.503
	N	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130
CL	CC	-.308**	1.000	0.006	-.272**	-.368**	-0.136	-0.046	-0.011	0.038	-0.131	-0.058	.206*	-0.105	0.022	-0.126
	p	0.000		0.946	0.002	0.000	0.122	0.600	0.899	0.667	0.138	0.514	0.019	0.235	0.808	0.154
	N	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130
Role	CC	0.096	0.006	1.000	.801**	.744**	.749**	.298**	0.164	.211*	.455**	.361**	0.086	-.297**	.373**	.217*
	p	0.276	0.946		0.000	0.000	0.000	0.001	0.063	0.016	0.000	0.000	0.332	0.001	0.000	0.013
	N	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130
We.	CC	.359**	-.272**	.801**	1.000	.906**	.901**	.367**	.200*	.225*	.543**	.361**	0.083	-.238**	.264**	.273**
	p	0.000	0.002	0.000		0.000	0.000	0.000	0.023	0.010	0.000	0.000	0.346	0.006	0.002	0.002
	N	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130
He.	CC	.380**	-.368**	.744**	.906**	1.000	.674**	.296**	0.142	0.153	.450**	.303**	-0.091	-0.101	.204*	.200*
	p	0.000	0.000	0,000	0,000		0,000	0,001	0,106	0,082	0,000	0,000	0,305	0,254	0,020	0,023
	N	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130
BMI	CC	,278**	-0.136	.749**	.901**	.674**	1.000	.399**	.234**	.279**	.527**	.323**	0.162	-.319**	.253**	.254**
	p	0.001	0.122	0.000	0.000	0.000		0.000	0.007	0.001	0.000	0.000	0.065	0.000	0.004	0.004
	N	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130
Σ6SF	CC	0.038	-0.046	.298**	.367**	.296**	.399**	1.000	.809**	.884**	.210*	0.083	0.094	-0.152	0.142	0.107
	p	0.665	0.600	0.001	0.000	0.001	0.000		0.000	0.000	0.017	0.347	0.290	0.084	0.106	0.224
	N	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130
%BFS	CC	-0.116	-0.011	0.164	.200*	0.142	.234**	.809**	1.000	.839**	0.141	-0.018	0.113	-.191*	0.069	0.058
	p	0.189	0.899	0.063	0.023	0.106	0.007	0.000		0.000	0.109	0.836	0.202	0.029	0.435	0.51
	N	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130
%BFY	CC	-.186*	0.038	.211*	.225*	0.153	.279**	.884**	.839**	1.000	0.157	0.042	0.144	-0.154	0.102	0.075
	p	0.034	0.667	0.016	0.010	0.082	0.001	0.000	0.000		0.074	0.636	0.101	0.080	0.249	0.398
	N	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130
DT	CC	0.032	-0.077	.421**	.521**	.433**	.479**	0.167	0.122	0.112	.774**	.610**	0.021	-.180*	.586**	.321**
	p	0.720	0.386	0.000	0.000	0.000	0.000	0.057	0.168	0.203	0.000	0.000	0.811	0.040	0.000	0
	N	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130
B	CC	-0.089	-0.058	.361**	.361**	.303**	.323**	0.083	-0.018	0.042	.625**	1.000	0.021	-.205*	.741**	.466**
	p	0.312	0.514	0.000	0.000	0.000	0.000	0.347	0.836	0.636	0.000		0.811	0.020	0.000	0
	N	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130
BD	CC	-0.086	.206*	0.086	0.083	-0.091	0.162	0.094	0.113	0.144	-0.096	0.021	1.000	-0.073	0.051	.215*
	p	0.329	0.019	0.332	0.346	0.305	0.065	0.290	0.202	0.101	0.277	0.811		0.406	0.566	0.014
	N	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130
C1	CC	0.023	-0.105	-.297**	-.238**	-0.101	-.319**	-0.152	-.191*	-0.154	-.174*	-.205*	-0.073	1.000	-.342**	-0.102
	p	0,791	0,235	0,001	0,006	0,254	0,000	0,084	0,029	0,080	0,048	0,020	0,406		0,000	0,248
	N	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130
C2	CC	-.202*	0.022	.373**	.264**	.204*	.253**	0.142	0.069	0.102	.500**	.741**	0.051	-.342**	1.000	.298**
	p	0.021	0.808	0.000	0.002	0.020	0.004	0.106	0.435	0.249	0.000	0.000	0.566	0.000		0.001
	N	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130
C3	CC	0.059	-0.126	.217*	.273**	.200*	.254**	0.107	0.058	0.075	.388**	.466**	.215*	-0.102	.298**	
	p	0.503	0.154	0.013	0.002	0.023	0.004	0.224	0.51	0.398	0	0	0.014	0.248	0.001	.
	N	130	130	130	130	130	130	130	130	130	130	130	130	130	130	

CL= Competitive level; We. = Weight; He.= Height; BMI= Body mass index; Σ6SF= Σ6Skin folds; %BF S. = %Body fat Slaugther; %BF Y.= % Body fat Yuashz; DT=Drive for Thinness scale; B= Bulimia scale; BD= Body Dissatisfaction scale

Lastly, the correlation analysis of all variables for the whole sample yielded significant positive relationships between sex and role and most of the anthropometric variables, as well as between many pairs of anthropometric variables. Likewise, the relationships between DT, B and BD scales, and the anthropometric variables were noteworthy. Similarly, relationships were found between the referring criteria and the ED subscales, as well as between the criteria and some anthropometric variables like BMI, weight and height (Table 7).

Some relevant negative relationships were sex-competitive level; Crit 2-sex; weight-competitive level; weight-age group; height-competitive level; Crit 1-DT, role, weight, BMI, Slaughter's percentage of body fat, B.

DISCUSSION

The analysis of the anthropometric variables revealed that more than half of the sample (63% of women and 60% of men) presented a healthy BMI, with gymnasts who competing at a higher level presented an increased BMI associated with their older age. Furthermore, no gymnasts presented obesity.

In the present study, women showed higher BMI values (19.54 kg/m2) than men, which agrees with Valles et al. (2020), who found that men had lower BMI values than women. This is contrary to the results of Papacharalampous et al. (2022) where males had a higher BMI than females (19.53 vs. 18.69).

As regards the under-18 group of gymnasts, more than half of the sample showed a BMI indicating normal weight or underweight with thinness grades 3 and 2. Only 2.7% of them presented overweight according to the indicators proposed by Cole et al. (2007). These results were similar to those obtained in other groups of gymnasts (Salas-Morillas & Vernetta, 2020; Taboada et al., 2016; Vernetta et al., 2018). Several authors have stated that, in many cases, such characteristics are due to a 'natural selection' process (Jonnalaggada et al., 2000), since light weight is beneficial in these highly technical sports and a determining factor of performance (Kaur & Koley, 2019). With regard to the 10 gymnasts aged 18 to 21, all competing at the international level (FIG), 70% presented normal weight and 30% were underweight, while overweight or obesity was not found in any of them.

International-level gymnasts showed statistically lower percentage of body fat compared to the national-level gymnasts (18.3 vs. 20.49) when using the formula proposed by Slaughter (1988). The percentages decreased when applying Yuhashz's (1974) equation: 13.75 vs. 13.99. Our results are similar to those obtained by Salas-Morillas et al. (2021) with junior and senior tops that correspond to the international level of our study and whose percentage body fat was 18.08, calculated using Slaughter's (1988) formula.

Female gymnasts presented higher values than men when using both formulas. These data are in keeping with the values obtained for female AcGs of different age groups (Taboada-Iglesias et al., 2021).

One factor that may affect these low results is the weekly training load, which could lead to a reduction in their adipose mass (Martins & Rodríguez Dos Santos, 2004; Peláez & Vernetta; 2020).

In general, the low percentages of body fat shown by our gymnasts support the findings by Salas-Morillas et al. (2022) in regard to performance in different competition exercises, where the gymnast's

body is thrown or supported against gravity during many elements. Therefore, it is beneficial to have a low percentage of body fat, like in some other disciplines (Kaur & Koley, 2019). The different levels of body fat are not only confirmed among other male and female gymnasts, but mainly result from sexual dimorphism which has a genetic and hormonal basis.

When analysing the ED risk factors, it was detected that the gymnasts of this study were vulnerable to developing this type of disorder. This finding agrees with the results obtained in previous studies (Anderson et al., 2011; De Bruin et al., 2007; Donti et al., 2021; Jardim et al., 2022; Valles et al., 2020; Vieira et al., 2009).

52.6% of the gymnasts were at risk of developing an ED. Previous studies have reported similar percentages in female gymnasts (Fortes et al., 2013ab; Laffitte et al., 2013; Martínez-Rodríguez et al., 2018).

The vulnerability to developing an ED has been assessed in this study through two risk scales:

1. Drive for thinness. Prevailing among women and at the international level in the majority of studies (Fortes et al., 2013ab; Iannidou & Venetsanou, 2019; Laffitte et al., 2013; Martínez-Rodríguez et al., 2020).
2. Bulimia. It was higher among international-level gymnasts. Actually, the competitive level is considered to be an important risk factor (Fortes et al., 2013ab; Laffitte et al., 2014).

The results revealed that the gymnasts competing at the international level met at least one referring criterion. Only 4.6% of the whole sample met criterion 1, which is exclusively related to low BMI values and entails a warning but not a referral to a specialist. The highest percentages in both levels corresponded to referring criterion 2, with slightly higher values for international-level and female gymnasts (78.6% vs. 64.7%, female international-level vs. female national-level gymnasts). They should be preventively referred, given the presence of a drive for thinness and problematic eating patterns. With regard to criterion 3, 16.8% of the gymnasts (5.2% of men and 16.8% of women) should be referred due to the existence of at least one extreme weight-control behaviour in the last three months (binge eating, vomiting, laxative, exercise) or due to a substantial weight loss in the last nine months. It was noteworthy that it was mostly international-level gymnasts who met criterion 3, which involves behavioural symptoms that indicate an ED and mandatory referral. Many of these gymnasts also reported excessive concerns regarding weight and eating as well as problematic eating patterns.

The referring percentages described in the present study may seem high in some cases, being above those described by Martínez-Rodríguez et al. (2020) where only two rhythmic gymnasts presenting an ED, or by Harriguer et al. (2014) who brought to light a relationship between training hours and ED presence, meaning that EDs decreased when training hours increased. Nonetheless, these comparisons must be made with care, since none of these studies applied the EDI-3-RF and the referring possibilities were not analysed.

In general, all studies examined the risk of developing an ED, but did not analyse in detail the symptoms prior to the ED. It must be highlighted that in ED studies with these athletes, it has been widely accepted that the higher the competitive level, the higher the dietary restriction or the presence of an inadequate food intake in order to stay thin (Anderson et al., 2011; De Bruin et al., 2007; Laffitte

et al., 2013). Although this variable was not analysed in our study, it was a direct consequence of one of the variables included, drive for thinness, which was pronounced at the highest competitive level. Various authors have considered such obsession to be the consequence of the thin-ideal internalisation and the pressure from parents and trainers to be thin (Fortes et al., 2014; Kosmidou et al., 2018; Valles et al., 2020).

Fortes et al. (2014) presented the thin-ideal internalisation as a potential bulimia predictor. In our study, female international-level gymnasts showed a higher risk of bulimia, as well as higher values on the drive for thinness scale. In the study by Laffitte et al. (2013), 63.5% of the gymnasts were at risk of developing bulimia, which was very similar to the 63.7% of female gymnasts in our study.

Looking at sex, EDI-3-RF scores related to the drive for thinness scale were slightly higher for female than for male gymnasts, but with no significant differences. Despite research involving male gymnasts being scarce, previous studies have confirmed an increased body dissatisfaction in this population, showing values that are similar to those of female gymnasts (Andersen, 2005).

A particularly concerning result of the present study was that the relationship between BMI and the behaviours corresponding to referring criterion 2 (bulimia and drive for thinness) applied to the vast majority of the sample of both levels, it is important to underline that the presence of pathologies in any of the items of part B of the questionnaire as a weight-control strategy was reason enough to refer the gymnast to a specialised centre. The results obtained reveal that Spanish gymnasts present an actual risk of developing an ED, which needs to be accepted and addressed.

The correlation analysis yielded significant associations between BMI and all variables except BD, as well as between percentage of body fat calculated using both formulas (Slaughter, 1988; Yuhasz, 1974) and referring criterion 1. These results were similar to the study by Laffite et al. (2013), where the gymnasts with lower percentages of body fat and inadequate dietary intake presented a higher tendency toward bulimia and anorexia. As regards the referral to treatment, criterion 1 was associated with Slaughter's percentage of body fat and BMI (which is logical, since this criterion is based on BMI), as well as with body dissatisfaction, drive for thinness and bulimia. Additionally, criterion 2 was associated with BMI, DT, B and criterion 1, which seems consistent, since this criterion is based on the association between BMI and DT, B. Lastly, referring criterion 3 was associated with BMI, drive for thinness and bulimia. This shows that behavioural symptoms that indicate the presence of an ED are caused by factors like dissatisfaction, which lead to obsessive behaviours and EDs. It is difficult to compare these results with previous research since no study involving gymnasts was found to have applied this questionnaire.

A later analysis was conducted, examining both sexes and both competitive levels (FIG and RFEG: Royal Spanish Gymnastics Federation) separately.

With regard to anthropometric variables in women, associations were found between the sum of 6 skinfold thicknesses and BMI, hip circumference and Slaughter's % body fat, as well as between both % body fat, in both competitive levels. These results are

obvious since the calculation of the variables is closely related. Similarly, the men's group showed associations between both % body fat and between them and the sum of 6 skinfold thicknesses.

When looking for potential associations and causes of the EDs, DT and B were observed to be related to BMI in women. By contrast, in men, DT and B were associated with each other but not with BMI. Various studies have reported a higher risk of ED in elite than in non-elite gymnasts (De Bruin et al., 2007; Dallas et al., 2016; Dallas et al., 2017; Donti et al. 2021; Dosil et al., 2012; Papacharalampous et al. 2022; Valles et al., 2020).

When examining the referring criteria in women of both levels, criterion 1 was associated with BMI, while criteria 2 and 3 were associated with BMI, DT and B, which is normal, as the criteria are built based on these variables. In men, only at the international level criteria 2 and 3 were associated with DT and B.

CONCLUSIONS

Overall, it can be concluded that there was an average percentage of gymnasts at risk of developing an ED, and body dissatisfaction was confirmed to be the major cause of these disorders. Female gymnasts competing at a higher level presented a higher risk of ED since they showed higher values in the variables drive for thinness, bulimia and body dissatisfaction. A significant relationship was found between low BMI and both bulimia and drive for thinness. Furthermore, the main causes of mandatory referral to a specialist in EDs of senior female international-level gymnasts were low BMI, low percentage of body fat, body dissatisfaction, drive for thinness and bulimia.

As a practical application, it is suggested to implement prevention and intervention strategies that are specifically aimed at AcGs, such as programmes to promote healthy eating habits, improve perceived body image and reduce the obsession with thinness.

This information should focus not only on gymnasts, but also on their family environment. Both trainers and families should be aware of the risk factors involved in the development of this type of issue and be able to contribute to the prevention and early detection of those gymnasts at a higher risk. After that, gymnasts should immediately start with therapy.

Among the main limitations, we can highlight, firstly, the lack of studies that analyse EDs in Spanish gymnasts in this discipline and the inequality of the sample in terms of gender. Another limitation lies in the lack of variables such as family context, pressure from coaches, parents and peers, as previous studies confirm the relationship between the risk of suffering from ED and these variables.

Likewise, the questionnaire used has been applied to gymnasts for the first time. However, it is a questionnaire that has validity and reliability to assess the constructs studied (Garner, 2004) and in our study the reliability with Cronbach's alpha was DT= 0.77 B= 0.79 and CI= 0.62.

In addition, a strength of the present study was that the gymnasts self-administered the questionnaire, they were offered, by those responsible for the study, privacy, anonymity and confidentiality, which may have helped them not to underestimate or overestimate their responses.

As a final limitation, it is worth highlighting the need for a larger sample to be able to segment it by categories and competitive modalities, as well as by the different roles that are assumed in this sport.

REFERENCES

Andersen, A. (2005). Eating disorders in males. En C.G. Fairburn & K. D. Brownell (Eds.). *Eating disorders and obesity*, (2a. Ed.). A comprehensive handbook. NY: The Guildford Press.

Anderson, C. M., Petrie, T. A., & Neumann, C. S. (2011). Psychosocial correlates of bulimic symptoms among NCAA Division-I Female Collegiate Gymnasts and Swimmers/Divers. *Journal of Sport and Exercise Psychology, 33*(4), 483–505. https://doi.org/10.1123/jsep.33.4.483

American Psychiatric Association (2013). *Diagnostic and statistical manual of mental disorders* (5th. Ed.). Washington, DC: APA.

Cole, T., Flegal, K., Nicholls, D., & Jackson, A. (2007). Body mass index cut offs to define thinness in children and adolescents. *International Survey*, 335, 194–197.

Dallas, G., Dallas, C., Simatos, J., & Simatos, J. (2016). Nutritional status and dietary assessment of elite female artistic and rhythmic gymnasts-a case study. *Science of Gymnastics Journal*, *8*(3), 255-269.

Dallas, G. C., Dallas, C. G., Simatos, E. J., & Simatos, J. E. (2017). Nutritional recommendations and guidelines for women in gymnastics: Current aspects and critical interventions. *Science of Gymnastics Journal*, *9*(1), 27-40

De Bruin, A. K., Oudejans, R. R., & Bakker, F. C. (2007). Dieting and body image in aesthetic sports: a comparison of dutch female gymnasts and non-aesthetic sport participants. *Psychology of Sport and Exercise, 8*(4), 507–520. https://doi.org/10.1016/j.psychsport.2006.10.002

Deutz, R. C., Benardot, D., Martin, D. E., & Cody, M. M. (2000). Relationship between energy deficits and body composition in elite female gymnasts and runners. *Medicine and Science in Sports and Exercise*, 32(3):659-68. https://doi.org/10.1097/00005768-200003000-00017

Donti, O., Donti, A., Gaspari, V., Pleksida, P., & Psychountaki, M. (2021). Are they too perfect to eat healthy? Association between eating disorder symptoms and perfectionism in adolescent rhythmic gymnasts. *Eating Behaviors*, *41*, 101514. https://doi.org/10.1016/j.eatbeh.2021.101514

Dosil, J., Díaz, I., Viñolas, A. & Díaz, O. (2012). Prevención y detección de los trastornos de alimentación en deportistas de alto rendimiento (CAR, CEARE y CTD). [Prevention and Detection of the Disorders of Food in Athletes of High Performance (CAR, CEARE and CTD). *Cuadernos de Psicología del Deporte*, *12*(1), 163-166. https://scielo.isciii.es/scielo.php?script=sci_arttext&pid=S1578-84232012000100019

Fernández Rivas, A. (2021). Anorexia nerviosa del adolescente y COVID-19: la pandemia colateral. [Anorexia nervosa in adolescents and COVID-19: the collateral pandemic]. *Revista Española de Endocrinología Pediátrica*, *12*(2). 10.3266/RevEspEndocrinolPediatr.pre2021.Nov.705

Fortes, L. S., Neves, C. M., Filgueiras, J. F., Almeida, S. S., & Ferreira, M. E. C. (2013a). Body dissatisfaction,

psychological commitment to exercise and eating behavior in young athletes from aesthetic sports. *Revista Brasileira de Cineantropometría y Desempenho Humano, 15*(6), 695–704. https://doi.org/10.5007/1980-0037.2013v15n6p695

Fortes, L. S., Almeida, S. S., & Ferreira, M. E. C. (2013b). Influência da ansiedade nos comportamentos de risco para os transtornos alimentares em ginastas. [Influence of anxiety on risk behaviors to eating disorders in gymnasts]. *Revista Brasileira de Atividade Física y Saúde, 18*(5), 546-553 https://doi.org/10.12820/rbafs.v.18n5p546

Fortes, L. S., Almeida, S. S., & Ferreira, M. E. C. (2014). A internalização do ideal de magreza afeta os comportamentos alimentares inadequados em atletas do sexo feminino da Ginástica Artística?. [The internalization of the thin ideal affects the inappropriate eating Behaviors in artistic gymnastic female athletes?]. *Revista Da Educacao Fisica, 25*(2), 181–191. https://doi.org/10.4025/reveducfis.v25i2.21866

García, J., Solbes, I., Expósito, E. & Navarro, E. (2012). Imagen corporal y riesgo de trastornos de la conducta alimentaria en población universitaria española: Diferencias de género. *Revista de Orientación Educacional*, *26*(50), 31-46.

Garner, D. M. (2004). Eating Disorder Inventory–3 Professional manual. Odessa, *Fl: Psychological Assessment Resources.*

Harriger, J. A., Witherington, D. C., & Bryan, A. D. (2014). Eating pathology in female gymnasts: potential risk and protective factors. *Body Image, 11*(4), 501-508. https://doi.org/10.1016/j.bodyim.2014.07.007

Herpertz-Dahlmann, B. (2009). Adolescent eating disorders: definitions, symptomatology, epidemiology and comorbidity. *Child* and *Adolescent Psychiatric Clinics of North America 18*(1), 31–47. https://doi.org/10.1016/j.chc.2008.07.005

Ioannidou, C., & Venetsanou, F. (2019). Social physique anxiety, disturbed eating attitudes and behaviors, and perceived pressure for thin body in competitive Rhythmic and Aerobic Gymnasts. *Science of Gymnastics Journal, 11*(3), 331-342. https://www.fsp.uni-lj.si/mma/-/20191027171537/

Jardim, M. L., Valencio, A. C. J., Menegassi, L. N., Da Silva, R. A., & Carteri, R. B. (2022). Risks of eating and image disorders are correlated with energy and macronutrient inadequacies in youth rhythmic gymnastics. *Science of Gymnastics Journal*, *14*(1), 85-96.

Jonnalaggada, S. S., Benardot, D., & Dill, M. N. (2000). Assessment of Under-Reporting of Energy Intake by Elite Female Gymnasts. *International Journal of Sport Nutrition and Exercise Metabolism, 10*(3)315-25. https://doi.org/10.1123/ijsnem.10.3.315

Kaur, K., & Koley, S. (2019). Anthropometric determinants of competitive performance in gymnastics: a systematic review. *International Journal Health Science and Research*, *9*(7), 249-256. https://www.ijhsr.org/IJHSR_Vol.9_Issue.7_July2019/38.pdf

Kosmidou, E., Giannitsopoulou, E., & Proios, M. (2018). Are body esteem, eating attitudes, pressure to be thin, body mass index and training age related in rhythmic gymnastics athletes?. *Science of Gymnastics Journal, 10*(2), 189–201. http://humanperformancelab.phed.aut

h.gr/wp-content/uploads/2018/08/Kosmidou-et-al.-2018.pdf

Laffitte, A. M., Zap, M., Leandro, P. P., & Colleon, P. G. K. (2013). Relationship between body composition, dietary intake and tendency to eating disorders in Rhythmic Gymnastics athletes from Paraná. RBNE-*Revista Brasileira de Nutrição Esportiva,* *7*(38), 99–107. http://www.rbne.com.br/index.php/rbne/article/view/375

Marfell-Jones M., Olds T., Stewart A., & Carter L. (2006). *International standards for anthropometric assessment.* ISAK: Potchefstroom, South Africa.

Martínez-Rodríguez, A., Leyva-Vela, B., Cuestas-Calero, B. J., & Reche, C. (2018). Deporte escolar y trastornos de la conducta alimentaria [School sports and eating disorders]. *Retos*, *34*, 236–239. https://doi.org/10.47197/retos.v0i34.59671

Martínez-Rodríguez, A., Reche-García, C., Martínez Fernández, M. C., & Martínez Sanz, J. M. (2020). Assessment of dietary-nutritional status, body composition, eating behaviour and image perception in rhythmic gymnastics athletes. *Nutrición Hospitalaria, 37*(6), 1217–1225. https://doi.org/10.20960/nh.03141

Martins, F. R., & Rodríguez Dos Santos, J. (2004). Leisure-time physical activity, diet and body composition. *Revista Brasileira de Educaçao Física e Esporte*, *18*(2), 159–167. https://doi.org/10.1590/S1807-55092004000200004

Nordin, SM., Harris, G., & Cumming, J. (2003). Disturbed Eating in Young, Competitive Gymnasts: Differences Between Three Gymnastics Disciplines. *European Journal of Sports Science, 3*(5), 1-14. https://doi.org/10.1080/174613903000735

02

OMS (2023), Clasificación Índice de Masa Corporal.

Papacharalampous, K. E., Dallas, C., & Dallas, G. (2022). Detection of eating disorders in male and female artistic gymnasts. *Science of Gymnastics Journal*, *14*(3), 421-433. https://doi.org/10.52165/sgj.14.3.421-433

Peláez-Barrios, E. M., & Vernetta-Santana, M. (2018). Estima corporal y factores antropométricos en adolescentes practicantes de acrobática. [Body esteem and anthropometric factors in acrobatic teenage gymnasts]. *TRANCES: Revista de Transmisión Del Conocimiento Educativo y de La Salud*, *10(*1), 511-526.

Peláez-Barrios, E. M., & Vernetta-Santana, M. (2020). Effects of sports practice on body image in male adolescents. ESHPA - Education, Sport, Health and Physical Activity. *ESHPA - Education, Sport, Health and Physical Activity*, *4*(3), 362–372. http://doi.org/10.5281/zenodo.4118376

Salas-Morillas, A., Gutiérrez-Sánchez, A., & Vernetta-Santana, M. (2022). Body composition and sports performance in acrobatic gymnasts. *International Journal of Morphology, 40*(1), 220–227. http://www.intjmorphol.com/wp-content/uploads/2022/02/art_32_401.pdf

Salas-Morillas, A., Gutiérrez-Sánchez, A., & Vernetta-Santana, M. (2021). Insatisfacción corporal y trastornos de conducta alimentaria en gimnastas: revisión sistemática**.** **[**Body dissatisfaction and eating disorders in gymnasts: a systematic review]. *Retos, 44,* 577-585. https://doi.org/10.47197/retos.v44i0.91042

Salas-Morillas, A., & Vernetta, M. (2020). Imagen corporal en adolescentes masculinos sedentarios y practicantes de gimnasia acrobática. Body image in

sedentary male adolescents who practice acrobatic gymnastics. En Marín, J. A. et al. (Ed). *Inclusión, Tecnología y Sociedad.* (pp. 548-562). Editorial Dykinson, S.L.

Slaughter, M., Lohman, T., Boileau, R., Horswill, C., Stillman, R., van Loan, M., & Bemben, D. (1988). Skinfold equation for estimation of body fatness in children and youth. *Human Biology, 60*(5), 709-23. https://pubmed.ncbi.nlm.nih.gov/3224965/

Taboada-Iglesias, Y., Gutiérrez-Sánchez, A., & Vernetta Santana, M. (2016). Anthropometric profile of elite acrobatic gymnasts and prediction of role performance. *The Journal of Sports Medicine and Physical Fitness, 56*(4), 433-42.

Taboada-Iglesias, Y., Vernetta Santana, M., & Gutiérrez-Sánchez, A. (2017). Anthropometric profile in different event categories of Acrobatic Gymnastics. *Journal of Human Kinetics*, *57*, 169-179. https://doi.org/10.1515/hukin-2017-0058

Taboada-Iglesias, Y., Vernetta-Santana, M., Alonso-Fernández, D., & Gutiérrez-Sánchez, Á. (2021). Phantom model and proportionality indices in acrobatic gymnastics age categories: a cross-sectional and descriptive study. *Revista Española de Nutrición Humana y Dietética*, *25*(Supl. 1), e1091-e1091. https://doi.org/10.14306/renhyd.25.S1.1091

Valles Verdugo, G., Hernández Armas, E., Baños, R., Moncada-Jiménez, J., & Rentería, I. (2020). Distorsión de la imagen corporal y trastornos alimentarios en adolescentes gimnastas respecto a un grupo control de adolescentes no gimnastas con un IMC similar**.** [Body image distortion and eating disorders in adolescent gymnasts compared to a control group of non-gymnasts with similar BMI]. *Retos*, *37*, 297–302. https://doi.org/10.47197/retos.v37i37.67090

Vernetta, M., & López Bedoya, J. (2005). Perfil motor de la gimnasia acrobática: características y planteamiento taxonómico [Motor profile of acrobatic gymnastics: Characteristics and taxonomic approach]. *Lecturas: EF y Deportes. Revista Digital, 10* (81). https://efdeportes.com/efd81/acrob.htm

Vernetta, M., Montosa, I., & Peláez, E. (2018). Estima corporal en gimnastas adolescentes de dos disciplinas coreográficas: gimnasia rítmica y gimnasia acrobática [Body esteem in adolescent gymnasts in two choreographic disciplines: rhythmic gymnastics and acrobatic gymnastics]. *Psychology, Society, y Education*, *10*(3), 301-314. https://doi.org/10.25115/psye.v10i1.2216

Vieira, J. L. L., Amorim, H. Z., Vieira, L. F., Amorim, A. C., & Rocha, P. G. M. da. (2009a). Distúrbios de atitudes alimentares e distorção da imagem corporal no contexto competitivo da ginástica rítmica. Eating disorders and body image distortion in the rhythmic gymnastics competitive context. *Revista Brasileira de Medicina Do Esporte, 15*(6), 410-414. https://doi.org/10.1590/s1517-86922009000700001

Vieira, J. L. L., Vieira, L. F., Amorim, H. Z., Amorim, A. C., & Rocha, P. G. M. da. (2009b). Distúrbios de atitudes alimentares e sua relação com o crescimento físico de atletas paranaenses de Ginástica Rítmica. Eating disorders and the relationship with the physical growth in Paranaenses rhythm gymnastic athletes. *Motriz, 15*(3), 552-561. https://www.periodicos.rc.biblioteca.unesp.br/index.php/motriz/article/download/2180/2472

Yuhasz, M. (1974). Physical Fitness Manual. London: Ontario

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