

General and pre-competition phases in young elite gymnasts: Eating behaviors, dietary intake, and somatotype.

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Abstract:

In women's artistic gymnastics, factors such as somatotype, nutritional status, and pubertal development have been widely examined because body size and composition considerably affect performance in this highly technical sport. Young elite gymnasts represent a nutritionally vulnerable population, with increased nutritional needs resulting from both their growth and biological maturation and the intense demands of daily training. This study aimed to determine dietary intake, body composition, and eating behavior in a group of young female gymnasts over the course of a competitive season. Twelve elite gymnasts participated ($n = 12$), with a mean age of 17.61 ± 3.39 years, and an age range of 14-25 years. Two assessments were conducted across two consecutive training periods (general preparation and pre-competitive), separated by a six-month interval. Body composition was evaluated using anthropometry (ISAK protocol), and dietary composition was assessed by weighing foods over three consecutive days, analyzing energy intake, macronutrients, and micronutrients (calcium, iron, vitamin B6, and vitamin B12). Eating behavior was assessed using the MEQ and KIDMED questionnaires. No significant differences between periods were observed in energy intake ($p = .992$), carbohydrates ($p = .204$), lipids ($p = .348$), or calcium intake ($p = .248$). However, significant differences were found in protein intake ($p = .042$), iron ($p = .028$), vitamin B6 ($p = .023$), and vitamin B12 ($p = .003$). Carbohydrate and several mineral intakes fell below the established updated recommendations, while lipid intake exceeded the stipulated ranges. Body composition remained relatively stable; however, height ($p = .005$) and bone mass ($p = .047$) showed significant differences during the pre-competitive phase. A predominance of the mesomorphic somatotype component was observed across both periods (general: 4.45 vs. precompetitive: 4.71). Non-significant improvements were detected in Mediterranean diet adherence, degree of mindful eating, and diet quality during the pre-competitive phase. Nevertheless, a significant positive correlation was found between the KIDMED index and the DIAL diet quality index ($r = 0.601$; $p < .001$). In conclusion, despite slight improvements observed between seasons, dietary intake remained below the updated nutritional recommendations established for elite gymnasts. The young gymnasts presented suboptimal dietary patterns across both periods, with no evidence of nutritional planning adjusted to the training cycle or competitive calendar. Specific nutritional education interventions targeting gymnastics, coaches, and families are needed to promote long-term athletic performance and health.

Key Words: Female artistic gymnastics, high-performance sport, body composition, dietary habits, mindful eating, nutritional education.

Introduction

Elite Artistic Gymnastics and Body Composition

Artistic gymnastics is a complex sport characterized by high physical demands, elevated technical difficulty, and a strong aesthetic component, requiring both general and specific physical preparation (González-Valencia, Isaza-Gómez & Parra-Estrada, 2021). Throughout the history of female artistic gymnastics, aspects such as gymnasts' somatotype, nutritional status, and pubertal development have been widely examined, given that body size and composition significantly influence performance in highly technical sports (Ackland et al., 2003).

Compared to other sports disciplines, gymnasts exhibit lower levels of body fat, a characteristic that favors an improved power-to-weight ratio and, consequently, superior competitive performance (Silva & Paiva, 2015; Kontele et al., 2021). In this context, dietary habits play a fundamental role, as inadequate energy intake may compromise energy balance, body composition, and the physiological development of gymnasts, negatively affecting both athletic performance and overall health status.

Young Gymnasts: A Vulnerable Population

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High-performance gymnasts constitute a nutritionally vulnerable population, with elevated nutritional demands arising from both their ongoing growth and biological maturation processes and the high training loads associated with daily practice (Malina et al., 2013). During the practice of this sport, conditional and coordinative capacities are developed from an early age, as the sports initiation process typically begins very early in life (Fuentes-Sapiencia & Fuentes-Carrasco, 2021). Training commonly starts between the ages of 3 and 4, which characterizes gymnastics as an early specialization sport oriented toward elite performance (Amelica & Muñoz-Sepúlveda, 2025). In this context, puberty represents a particularly critical stage, as it constitutes a transitional period between childhood and adulthood, accompanied by significant biological, psychological, and emotional changes closely related to growth and development. When these processes coincide with intensive training programs and pressures associated with body composition and athletic performance, the nutritional requirements of gymnasts may increase substantially.

During this period, several authors (Malina, Bouchard & Bar-Or, 2004) emphasized the importance of adequate nutrition in elite gymnasts, as sufficient intake of energy and nutrients — particularly proteins — promotes the attainment of final adult height and supports training load tolerance. Conversely, insufficient energy and protein intake may lead to chronic undernutrition, inducing growth delays, compromising athletic performance, and negatively affecting the overall development of the gymnast (Fuentes-Sapiencia & Fuentes-Carrasco, 2021).

Dietary Intake

The American College of Sports Medicine (ACSM, 2016) proposed specific dietary guidelines aimed at optimizing performance, establishing body weight-relative requirements for two of the three energy-providing macronutrients — carbohydrates (CHO) and proteins (P) — with recommended intake ranges defined according to the duration and type of sport practiced.

According to the ACSM (2016), dietary intake in high-level gymnasts is an essential determinant of professional performance. Young athletes may benefit from exercise, provided they adjust their diets in terms of energy and nutrient content to meet the specific demands of their training period. Meeting energy and macronutrient recommendations constitutes a primary dietary objective across all training phases.

Regarding macronutrient distribution, the Acceptable Macronutrient Distribution Ranges (AMDRs) established by the Food and Nutrition Board (FNB, 2006) for the general population suggest that carbohydrates should contribute 45–65% of total energy intake, proteins 10–30%, and lipids 20–35%. Additionally, the ACSM recommends that dietary fat intake should not fall below 20% of total energy. Weight-relative intake recommendations include 3–12 g/kg/day for carbohydrates and 1.2–2.0 g/kg/day for proteins (ACSM, 2016).

With respect to micronutrients, no specific requirements have been established for highly active populations. For this reason, the Dietary Reference Intakes (DRIs) are used as reference values, recommending a daily calcium intake of 1000–1300mg depending on age range (up to 18 or under 18 years old), and an iron intake of 15–18 mg per day for females, adjusted to their maturational stage. The FNB (2006) recommends daily intakes of 1.2–1.3 mg of vitamin B6 and 2.4 µg of vitamin B12 for adolescent and young adult females.

According to Desbrow (2014), in aesthetic sports such as gymnastics, physical performance may be compromised when nutritional education is inadequate. It is therefore necessary to promote nutritional literacy regarding the composition of different foods and beverages that athletes should consume in order to meet the specific demands of training and competition.

In young athletes, dietary energy intake derives from the consumption of macronutrients — CHO, P, and lipids (L) and should therefore be determined based on individual energy expenditure associated with training load. According to Hannon, Close, & Morton (2020), adequate nutritional planning not only optimizes growth and biological maturation but may also promote training adaptations, enhance athletic performance, support adequate recovery, and contribute to optimal physical, cognitive, and psychological health, enabling athletes to cope with the physical and emotional demands of competition.

Carbohydrates (CHO) constitute the primary energy source during moderate-to-high intensity physical exercise, and their relative contribution increases proportionally with training load (Burke et al., 2011). Proteins (P) are essential for muscle repair and growth, maintaining a relatively constant proportion of energy distribution with respect to total energy expenditure (Phillips & Van Loon, 2011; Areta, 2013). Lipids (L) also represent an important energy source, particularly during low-intensity exercise, with their contribution to total energy intake potentially increasing during prolonged training loads. Micronutrients (vitamins and minerals) do not provide energy but play a relevant functional role in the organism. In particular, dietary calcium is of special importance in young gymnasts, as it plays an essential role in bone development and mineralization. This process reaches its peak bone density during adolescence. Calcium also participates in muscle contraction, and ensuring adequate intake (AI) is a priority for the prevention of bone injuries (Muñoz et al., 2003).

Another key micronutrient, vitamin B6, is involved in cellular metabolism, and its deficiency may limit the synthesis of essential amino acids or impair the proper maturation of red blood cells, potentially reducing oxygen transport to muscle fibers and influencing maximal aerobic capacity (Martínez Rodríguez et al., 2020). Furthermore, vitamin B12 deficiency has been associated with sleep disturbances, gastrointestinal disorders, growth impairment, and alterations in tissue development and maturation (Martínez Rodríguez et al., 2020).

Both vitamins B6 and B12 play key roles in energy metabolism, neurological function, and the maintenance of optimal performance in sport.

Diet Quality

Adolescence represents a critical period for the establishment of healthy dietary habits, particularly within the context of high-level sport, where physiological and energy demands are elevated. It is well established (Ciccarelli, 2013) that, at this stage, biological development and adherence to a high-quality diet, rich in micronutrients and balanced in energy distribution, are key determinants of functional integrity and athletic performance (Ciccarelli, 2013). In this regard, an adequate diet should be characterized by variety, high nutritional density, and energy intake adjusted to individual needs (Martínez-González & Sañudo, 2020).

Among dietary reference models, the Mediterranean diet (MD) is an example of high nutritional quality, based on the traditional eating habits of Mediterranean countries. It is characterized by a high consumption of plant-based foods — including vegetables, fruits, legumes, nuts, and cereals — as well as olive oil as the primary fat source, along with moderate consumption of fish, eggs, and dairy products (preferably yogurt or cheese), and a lower intake of meat and animal fats (Martínez-González & Sañudo, 2020). The MD is widely considered a prototype of a healthy and balanced diet due to its adequate caloric contribution and sufficient micronutrient content in appropriate proportions (Davis, Bryan, Hodgson, & Murphy, 2015), contributing not only to optimizing the training and competition capacity of gymnasts but also to supporting recovery and maintaining overall health (Stellingwerff et al., 2011).

Mindful Eating

In parallel, within the framework of healthy nutritional habits, it is also essential to evaluate eating behavior from a new perspective: the degree of attention paid to eating, or the degree of mindful eating. A bidirectional communication between the central nervous system and the gastrointestinal tract has been established through the gut-brain axis (Lacámara, 2023), which allows for the examination of mindful eating as a potential component in the regulation of eating behavior. It has been proposed that applying mindfulness to the act of eating may enhance the perception of internal hunger and satiety signals, as well as improve emotional regulation associated with food intake (Lacámara, 2023). Mindful Eating may offer benefits in helping to incorporate healthy long-term dietary habits (De Castro & Del Carmen, 2021), which could be particularly relevant for young athletes who are frequently exposed to high physical demands and psychological pressures, often related to body composition.

From this perspective, the present study aims to determine, in a group of young female gymnasts, the composition of their diet, their body composition, and their eating behavior across two different and consecutive sport periods.

Material & methods

Participants

Twelve young elite female gymnasts ($n = 12$) participated in this study, with a mean age of 17.61 ± 3.39 years, ranging from 14 to 25 years of age. Data collection was conducted at two time points across two consecutive competitive seasons, separated by a six-month interval. Inclusion Criteria: Membership in the Spanish National Female Artistic Gymnastics Team and training at the High-Performance Sports Center of Madrid (Centro de Alto Rendimiento Deportivo de Madrid, CAR Madrid).

Procedure

Body composition and dietary intake were assessed across two distinct training periods — referred to as the general preparation phase and the pre-competitive phase — separated by a six-month interval. The assessment included a quantitative evaluation of dietary intake to analyze energy contribution, energy-providing macronutrients, and four micronutrients (calcium, iron, vitamin B6, and vitamin B12). Macronutrient and micronutrient consumption was determined according to food group, with particular attention to vegetable intake. In addition, qualitative assessments of adherence to the Mediterranean diet were conducted, and the degree of mindful eating was estimated.

Quantitative Dietary Assessment

Over a period of three consecutive days (two weekdays and one weekend day) within each training phase, all foods consumed by the gymnasts during the three main meals of the day (breakfast, mid-morning snack, and dinner) were weighed. Foods consumed between meals or as snacks — including mid-morning snacks, afternoon snacks, and late-night snacks — were recorded via WhatsApp, with participants submitting photographs of their intake.

Subsequently, all food items were entered into the food composition software Dial® (Alce Ingeniería, S.A., Madrid, Spain). The software database was continuously updated through daily visits to the dining hall kitchen, where new recipes for consumed foods were recorded. Similarly, new dietary supplements used by the gymnasts were registered in the Dial® software. The DIAL software converts food data into macro- and micronutrient values and estimates, based on individual consumption, a diet quality index referred to as the DQI-i (Diet Quality Index-International).

Body Composition

Body composition was determined through the collection of 13 anthropometric measurements, including bone diameters, muscle girths, and skinfold thicknesses, following the ISAK protocol (International Society for the Advancement of Kinanthropometry). For each training period, individual somatotypes were calculated and a group somatochart was estimated.

Assessment of Eating Behavior

During both training periods, participants completed questionnaires assessing dietary quality and adherence to the Mediterranean diet — the KIDMED test (Serra et al., 2004) — as well as the degree of mindful eating, evaluated using the Mindful Eating Questionnaire (MEQ; Framson et al., 2009).

Instruments

Nutritional Assessment Instruments: A digital precision scale Mettler Toledo® (Barcelona, Spain; precision: 1 g) was used for food weighing. Dietary composition data were obtained and analyzed using the food composition software Dial® (Alce Ingeniería, S.A., Madrid, Spain). The DIAL software provides both quantitative and qualitative dietary analysis through the DQI-i (Diet Quality Index-International), which is scored on a scale with a maximum of 100 points.

Anthropometric Assessment Instruments: The ISAK protocol was followed throughout (Esparza & Vaquero, 2023). Body mass was measured using an XMTZC-02HM scale with a precision of ± 0.1 kg (Xiaomi, Beijing, China); height was measured using a SECA 213 portable stadiometer with a precision of ± 0.1 cm (SECA, Hamburg, Germany); bone diameters (humerus, wrist, femur, and ankle) were measured using a bone caliper with a precision of ± 0.1 cm (Holtain, Crosswell, UK); girths (relaxed arm, flexed arm, forearm, wrist, waist, gluteal, mid-thigh, calf, and ankle) were measured using a flexible steel tape measure with a precision of ± 0.1 cm (CESCORF, Porto Alegre, Brazil). Skinfold thicknesses (triceps, subscapular, biceps, iliac crest, supraspinal, abdominal, front thigh, and medial calf) were measured using a Holtain skinfold caliper with a precision of ± 0.2 mm (Holtain, Crosswell, UK). Body mass index (BMI), sex, ethnicity, and training period were also recorded.

Questionnaires: Adherence to the Mediterranean diet (MD) was assessed using the validated KIDMED questionnaire (Serra et al., 2004). The KIDMED consists of 16 items with a dichotomous response format (yes/no) to evaluate dietary quality. Based on the total score obtained, participants are classified into three categories: "very poor dietary quality" (≤ 3), "needs improvement in dietary habits" (4–7), and "optimal" (≥ 8). The degree of mindful eating was assessed using the Mindful Eating Questionnaire (MEQ; Framson et al., 2009), adapted for a predominantly adolescent population. The MEQ is a tool designed to evaluate an individual's capacity to eat mindfully and attentively. It consists of 28 items scored on a 4-point Likert scale (ranging from 1 to 4), assessing five dimensions of eating behavior: Awareness (Aw), Distraction (Di), Disinhibition (Dis), Emotional Response (ER), and External Cues (EC). Each dimension yields an independent score, and the mean of the five subscale scores constitutes the overall mindful eating index.

Statistical Analysis:

Data obtained across both training periods were analyzed using IBM SPSS Statistics, version 29.0. Descriptive statistics were computed for all variables. Normality was assessed using the Shapiro-Wilk test and homogeneity of variance was evaluated using Levene's test, both at a confidence interval of 95% ($p = 0.05$). Results confirmed the normality of all observed variables and homogeneity of variances. Subsequently, a paired-samples Student's t-test was conducted to compare means between the two time points, and Cohen's d effect sizes were calculated to evaluate the magnitude of pre-post differences for all study variables.

Results

Table I presents the descriptive results for energy and macronutrient intake. Total energy intake (Table I) showed no significant differences between the general preparation phase and the pre-competitive phase. Regarding macronutrients, carbohydrate intake (g/kg/day) decreased from one period to another, although no significant differences were observed. Fat intake (g/day) increased during the pre-competitive phase; however, this change also did not reach statistical significance between the two periods. In contrast, protein intake (g/kg/day) showed a statistically significant decrease during the pre-competitive phase, with a moderate effect size (Table I).

Table I. Descriptive statistics of macronutrients and energy intake across training periods.

	General Phase (PRE)		Pre-competitive Phase (POST)				
	<i>X</i>	<i>De</i>	<i>X</i>	<i>De</i>	<i>t</i> ₍₁₁₎	<i>d</i>	<i>P</i> ₍₁₎
CHO intake (g/kg/d)	4,07	1,77	3,58	0,60	0,859	0,248	0,204
Protein intake (g/kg/d)	2,04	0,63	1,72	0,33	1,904	0,550 ⁽²⁾	0,042 *
Fat intake (g/d)	90,53	21,61	93,72	22,98	-0,400	-0,115	0,348
Energy intake (Kcal/d)	1915	339	1916	303	-0,010	-0,003	0,992

* Statistical significance: $p \leq .05$.

(1) One-tailed p-value.

(2) Moderate effect size ($0.50 \leq d \leq 0.70$).

Table II presents the percentage distribution of energy from macronutrients across both training periods. The results indicate that carbohydrate intake (%) did not meet the ranges established by the Acceptable Macronutrient Distribution Ranges (AMDRs), whereas fat intake exceeded the recommended values.

Table II. *Percentage of energy derived from each macronutrient.*

	General Phase (PRE)		Pre-competitive Phase (POST)	
	<i>X</i>	<i>De</i>	<i>X</i>	<i>De</i>
CHO intake (%)	40,46*	8,23	39,48*	6,10
Protein intake (%)	19,55	2,72	17,48	2,19
Fat intake (%)	40,21**	7,84	43,01**	5,23

* Values below the recommended range (according to the AMDRs).

** Values above the recommended range (according to the AMDRs).

Table III presents the intake of two minerals (calcium and iron) and two vitamins (B6 and B12) across both training periods. Calcium intake (mg) during the general preparation phase exceeded two-thirds of the DRI reference value (67%); however, it decreased by 7% during the pre-competitive phase. Calcium intake remained below the Adequate Intake (AI) values established by the Food and Nutrition Board across both periods, with a non-significant decrease from one phase to the other.

A similar trend toward reduced micronutrient intake was observed during the pre-competitive phase. Specifically, iron (mg), vitamin B6 (mg), and vitamin B12 (µg) all decreased during the pre-competitive phase, with moderate effect sizes for iron and vitamin B6, and a large effect size for vitamin B12 (Table III).

In contrast, vitamins B6 and B12 met the recommended intake levels established by the Dietary Reference Intakes (DRIs), whereas both minerals — calcium and iron — failed to reach the recommended values across both training periods (Table III).

Table III. *Descriptive statistics for micronutrient intake (calcium, iron, vitamin B6, and vitamin B12).*

	General Phase (PRE)		Pre-competitive Phase (POST)		<i>t</i> (11)	<i>d</i>	<i>P</i> (1)
	<i>X</i>	<i>De</i>	<i>X</i>	<i>De</i>			
Ca intake (mg)	822	332,17	747	234,48	0,703	0,203	0,248
Fe intake (mg)	15,80	7,53	11,38	2,73	2,127	0,614⁽²⁾	0,028*
Vitamin B6 intake (mg)	3,55	1,81	2,16	0,71	2,252	0,650⁽²⁾	0,023*
Vitamin B12 intake (µg)	5,86	1,99	3,60	1,62	3,400	0,982⁽³⁾	0,003*

* Statistical significance: $p \leq .05$.

(1) One-tailed p-value.

(2) Moderate effect size: $0.50 \leq d \leq 0.70$.

(3) Large effect size: $d \geq .80$.

Table IV details the contribution of protein, iron, and calcium from a specific food group: vegetables. All three nutrients showed a statistically significant increase in their contribution through vegetable intake during the pre-competitive phase, with a large effect size (Table IV). However, this change did not result in an overall increase in total daily protein intake.

Table IV. *Descriptive data by food group (vegetables) as a percentage.*

		General Phase (PRE)		Pre-competitive Phase (POST)		<i>t</i> (11)	<i>d</i>	<i>P</i> (1)
		<i>X</i>	<i>De</i>	<i>X</i>	<i>De</i>			
Protein intake (%) from vegetables		5,82	3,58	7,79	2,63	-2,639	-0,762⁽²⁾	0,012*
Fe intake (%) from vegetables		14,79	9,41	21,45	8,29	-2,748	-0,793⁽²⁾	0,009*
Ca intake (%) from vegetables		7,53	3,83	10,12	4,71	-2,634	-0,760⁽²⁾	0,012*

* Statistical significance: $p \leq .05$.

(1) One-tailed p-value.

(2) Large effect size: $d \geq .80$.

Body composition:

The anthropometric data expressed in kilograms for muscle mass, bone mass, and fat mass, as well as body weight and height across both training periods separated by a six-month interval, are presented in Table V. Regarding bone mass, a statistically significant increase was observed from one period to the other, with a moderate effect size. Height also demonstrated a significant increase during the subsequent pre-competitive phase. In contrast, muscle mass and fat mass showed similar values across both periods (Table V). A slight increase in body weight was also observed; however, the differences were not statistically significant and effect sizes were small (Table V).

Table V. Descriptive statistics for anthropometric variables across both training periods.

	General Phase (PRE)		Pre-competitive Phase (POST)		$t_{(11)}$	d	$P^{(1)}$
	X	De	X	De			
Muscle mass (kg)	21,16	2,16	21,44	2,45	-1,010	-0,292⁽²⁾	0,167
Bone mass (kg)	8,31	0,86	8,44	0,93	-1,837	-0,530⁽³⁾	0,047*
Fat mass (kg)	4,39	1,47	4,43	1,35	-0,523	-0,151	0,306
Residual mass (kg)	15,78	2,64	15,56	1,99	0,693	0,200	0,251
Body weight (kg)	49,63	6,07	49,86	6,02	-0,470	-0,136	0,324
Height (cm)	154,79	5,16	155,61	5,33	-3,164	-0,913⁽⁴⁾	0,005*

* Statistical significance: $p \leq .05$.

(1) One-tailed p-value.

(2) Small effect size: $d \leq .49$.

(3) Moderate effect size: $.50 \leq d \leq .70$.

(4) Large effect size: $d > .80$.

The somatotype assessment of the gymnasts, based on anthropometric results and calculated using the Heath and Carter method (1990), indicates that the predominant somatotype component is Mesomorphy. The results are presented in Table VI.

Table VI. Somatotype components of the gymnasts across both training periods.

	Mean General Phase (PRE)		Mean Pre-competitive Phase (POST)		$t^{(1)}$	d	$p^{(1)}$
	X	De	X	De			
Endomorphy	2,10	0,90	2,22	0,81	-1,617	-0,467	0,067
Mesomorphy	4,45	0,95	4,71	1,01	-1,792	-0,517	0,050*
Ectomorphy	2,48	0,96	2,39	0,82	0,771	0,222	0,229

* Statistical significance: $p \leq .05$.

(1) One-tailed p-value.

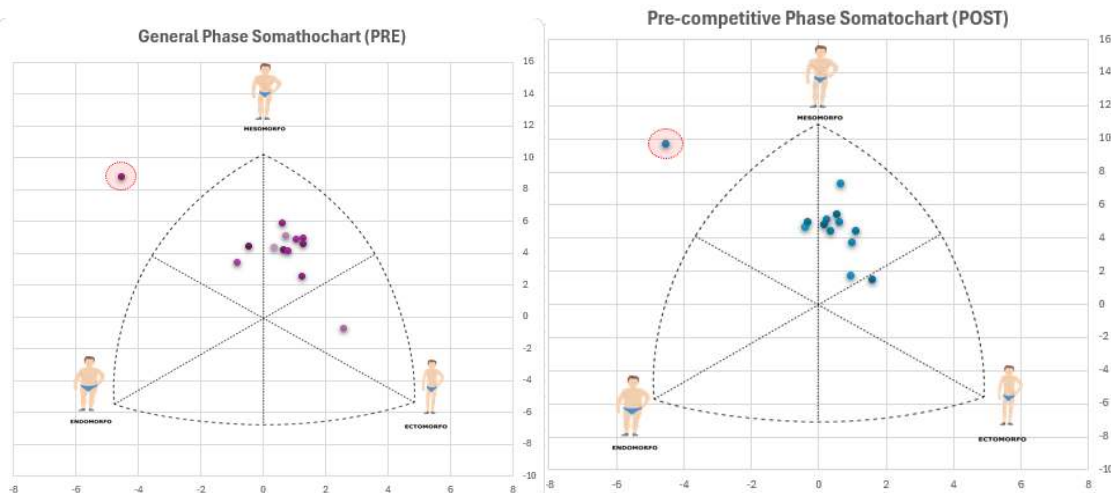


Figure 1. Somatotype distribution of the gymnasts on the somatochart during the general preparation phase (PRE) and the pre-competitive phase (POST). Own elaboration.

The distribution of the three mean components (Endomorphy–Mesomorphy–Ectomorphy) defining the somatotype for the somatochart representation during the general preparation phase (PRE) were 2.10–4.45–2.48, respectively. A predominance of the mesomorphic component over the other two was evident. In the group somatochart representation (Figure I), the majority of gymnasts were concentrated in the upper-central region of the somatochart, reflecting low endomorphy values, high mesomorphy, and moderate ectomorphy. The mean somatochart coordinates were $x = 0.38$; $y = 4.33$ (Figure 2), indicating a slight ectomorphic tendency with a strong muscular component.

Similarly, in the somatochart corresponding to the pre-competitive phase (POST), the general pattern remained similar to that of the general preparation phase, preserving the predominance of the mesomorphic component. The pre-competitive phase somatotype (2.23–4.71–2.39) indicated a slight increase in both mesomorphy and endomorphy. The mean coordinates shifted to $x = 0.16$ and increased to $y = 4.81$ (Figure II), suggesting a slight displacement toward greater muscularity.

The individual distribution was similar across both measurement points, with a slight upward shift of the group mean on the somatochart, indicating a minor increase in the mesomorphic component (Figure II).

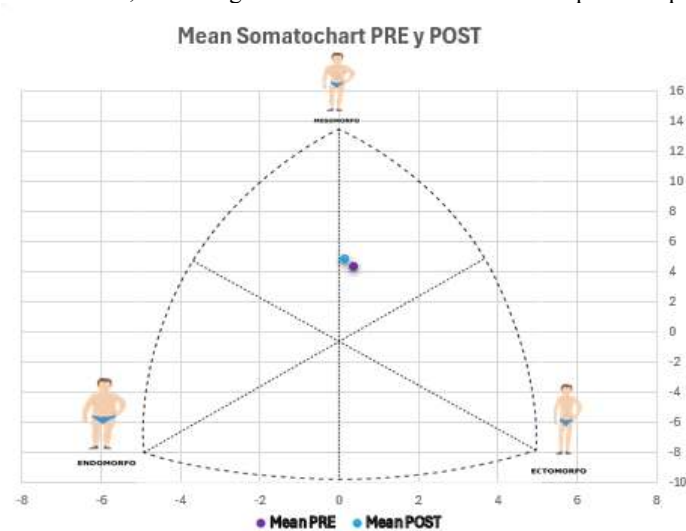


Figure II. Mean somatotype distribution during the general preparation phase (PRE) and the pre-competitive phase (POST). Own elaboration.

Questionnaire Assessment:

The qualitative dietary analysis, including data on eating behavior revealed by the three questionnaires, is presented in Table VII.

Table VII. Descriptive statistics for the qualitative dietary assessment across both training periods.

	General Phase (PRE)		Pre-competitive Phase (POST)		$t_{(11)}$	d	$P^{(1)}$
	X	De	X	De			
Adherence to the Mediterranean diet-KIDMED	7,08	3,18	7,83	2,33	-0,806	-0,233	0,219
Diet quality (%)	66,73	12,99	71,01	13,28	0,268	-0,337	0,134
Mindful eating - MEQ	2,76	0,21	2,83	0,21	-0,909	-0,262	0,191

* Significación estadística $p \leq 0,05$.

(1) One-tailed p-value.

The mean adherence score to the Mediterranean diet across both training periods was 7.70 ± 2.68 points, indicating a level below the optimal MD model (scored at 12 points). A slight increase in MD adherence was observed during the pre-competitive phase; however, this change yielded no meaningful effect size, and no statistically significant differences were found (Table VII).

The mean diet quality score across both training periods, assessed through the DQI-i index, reached a value of $66.73\% \pm 12.99$. A 4% increase was observed during the pre-competitive phase; however, no statistically significant differences were found between the two periods (Table VII).

Regarding the degree of mindful eating, rated on a 4-point scale, a small non-significant increase was observed during the pre-competitive phase (Table VII).

Correlations between questionnaire results were analyzed, revealing a strong correlation between Mediterranean diet adherence (KIDMED) and the DIAL diet quality index ($r = 0.601$, $p < .001$), with high statistical significance (Table VIII). However, the degree of mindful eating did not correlate positively with dietary quality outcomes (Table VIII).

Table VIII. Correlations between diet quality index (%), the MEQ, and the KIDMED score.

		KIDMED	% Diet quality	MEQ
Pearson Correlation	KIDMED	1,000	0,601**	0,252
	% Diet quality	0,601**	1,000	0,279
	MEQ	0,252	0,279	1,000
P	KIDMED	1,000	0,000*	0,102
	% Diet quality	0,000*	1,000	0,079
	MEQ	0,102	0,079	1,000

*Statistical significance: $p \leq .05$.

** Strong correlation: 0.60 – 0.79.

Dicussion

The present study is of particular relevance as it examines dietary intake, body composition, and eating behavior in a group of young female athletes — specifically, a group of gymnasts competing at the national and international level.

Macronutrients:

The results of the present study indicate that total energy intake (kcal) remained relatively stable across the two analyzed periods, with a slight increase during the pre-competitive phase. These findings are in line with previous reports in high-level gymnasts (Deutz et al., 2000).

However, the distribution of macronutrient intake (AMDR) did not align with the recommendations established by the Food and Nutrition Board (FNB, 2006) for the general population. An increased fat intake above the recommended values was observed, accompanied by a reduced consumption of carbohydrates and proteins during the pre-competitive period. Although protein intake remained within the suggested ranges, carbohydrate intake fell below the recommendations.

Protein intake met the body weight-relative values suggested by the ACSM (2016). In contrast, carbohydrate intake was at the lower limit established by the American College of Sports Medicine (2016) and did not meet the recommendations required to cover the demands of daily training. This finding is consistent with those reported by Martínez Rodríguez et al. (2020), who observed insufficient carbohydrate intake in young gymnasts, particularly during the pre-competitive period.

Given their role as the primary energy substrate during high-intensity exercise, a deficiency in carbohydrate intake could promote early onset of fatigue, compromise recovery, and limit athletic performance. Martínez Rodríguez et al. (2020) noted that insufficient carbohydrate intake may disrupt certain metabolic processes and negatively affect overall health status. It has also been reported (Martínez Rodríguez et al., 2020) that young gymnasts fail to meet the recommended requirements associated with the demands of their growth, training adaptation, and muscle mass maintenance.

Regarding lipid intake, similar results have been reported by Villa M. et al. (2021), who observed a fat intake above the recommended levels. In the present study, fats contributed substantially to total energy intake. It should be noted (Benardot, 2000) that lipids do not constitute the primary energy source in predominantly anaerobic sports such as artistic gymnastics. Furthermore, it has been suggested (Kontele, Grammatikopoulou, & Vassilakou, 2021) that excess fat mass is often associated with a high intake of fat and/or energy, which may negatively affect movement efficiency. In this context, elite gymnasts exhibit specific body characteristics, including smaller body size and lower body fat composition (reduced endomorphy), which are associated with improved physical performance in acrobatic sports.

In contrast, other studies (Martínez Rodríguez et al., 2020; Desbrow et al., 2014; Cupisti et al., 2000) report opposing findings, as they did not observe lipid intakes exceeding recommendations, or even reported values below adequate ranges. In this regard, Benardot (2000) suggests that an optimal dietary pattern for gymnasts should be characterized by moderate fat and adequate carbohydrate intake, which would be more favorable for optimizing performance in this sport.

Micronutrients:

With respect to mineral intake, several studies (San Mauro Martín et al., 2016; Tan et al., 2016; Martínez Rodríguez et al., 2020; Villa M. et al., 2021) have reported insufficient micronutrient intake in gymnasts. In the present study, calcium and iron intake were notably reduced during the pre-competitive phase. In general, the Dietary Reference Intakes (DRIs) established by the Food and Nutrition Board (2006) were not met for either mineral. In this regard, Malina, Bouchard & Bar-Or (2004), following dietary assessments in populations of young female athletes, also identified insufficient intakes of iron and/or folic acid.

Vitamin B6 and B12 intake likewise failed to meet the recommendations established by the Food and Nutrition Board (2006) during the pre-competitive period. A study conducted with young rhythmic gymnasts by D'Alessandro C. et al. (2007), published in *Pediatric Exercise Science*, along with subsequent research (Cupisti et al., 2000; Villa et al., 2021) analyzing the dietary intake of elite synchronized skaters (Ziegler & Jonnalagadda, 2006), described insufficient intakes of calcium, iron, and several vitamins. Additionally, the study by Kramaric M. et al. (2021) demonstrated that adolescent artistic gymnasts presented intakes below recommendations for the majority of evaluated micronutrients. Collectively, these findings reinforce the evidence that young gymnasts constitute a population vulnerable to suboptimal intakes of certain micronutrients, likely related to restrictive dietary patterns and inadequate nutritional planning, which should be complemented by education on food composition and processing.

Overall, suboptimal dietary patterns were observed across both training periods. The absence of significant changes between periods suggests that no structured dietary strategy is implemented in accordance with the competitive calendar. In this context, it is essential to implement systematic nutritional education programs and promote adequate dietary habits. Providing athletes with practical knowledge and tools to adjust their macronutrient and micronutrient energy intake to the demands of each training phase would be beneficial for improving both athletic performance and long-term health.

Anthropometry:

Based on the anthropometric data, a statistically significant increase in height ($p = .005$; $d = -0.913$) and bone mass ($p = .047$; $d = -0.530$) was observed during the pre-competitive phase compared to the general preparation phase, which is consistent with natural growth processes over the six-month interval. Several studies (Vicente-Rodríguez et al., 2005; Robinson et al., 1995) have demonstrated that elite gymnasts exhibit greater bone mineral density and content than other athletic groups. In the present study, bone mineral density was not measured directly; however, bone mass gains consistent with height growth were observed. It has been reported (Markou et al., 2004) that the practice of artistic gymnastics during adolescence may enhance bone development and support the maintenance of bone mass in adulthood. Furthermore, the increase in bone mass in this population may be explained by osteogenic adaptation induced by the mechanical loading characteristic of artistic gymnastics. Bacciotti et al. (2017) highlight that high-impact sports promote gains in bone mineral density, particularly during developmental periods, and that intensified training during the pre-competitive phase may potentiate these structural adaptations, even in young adult gymnasts.

The increase in height may be partly attributed to somatic growth associated with late adolescence and early adulthood, given the young age of some of the gymnasts in the present study. The systematic review by Bacciotti et al. (2017) indicates that, although elite artistic gymnasts tend to present lower mean height compared to other sport disciplines, intensive training does not compromise longitudinal growth. Similarly, Irurtia Amigó et al. (2009) and Marina (2008) reported that, from childhood to early adulthood, gymnasts tend to progressively increase in both height and body weight, reflecting normal biological development patterns that overlap with the effects of training.

In this regard, the changes observed in variables such as bone mass and height are consistent with those described by Canda Moreno (2012) in young Spanish athletic populations, where growth and biological maturation significantly influence the evolution of these two anthropometric variables. Canda Moreno (2012) notes that, in athletes at developmental stages, changes in body composition respond to both training stimuli and physiological growth processes, which may explain the variations found in the present study.

The small increase in muscle mass observed during the pre-competitive phase may be explained by the specific training demands associated with the proximity of competition. In this regard, Giorgi et al. (2025) demonstrated that, in female artistic gymnasts, a positive relationship exists between training volume and intensity and variables related to fat-free mass and muscle development, reflecting specific adaptations to competitive training. Furthermore, Bacciotti et al. (2017) highlight that muscular and anthropometric adaptations, including moderate increases in muscle mass during preparation periods, are consistent with the physical demands of female artistic gymnastics and its high level of specialization.

Throughout the study season, gymnasts' fat mass remained relatively stable, showing a slight increase from the general to the pre-competitive phase without reaching statistical significance. According to Canda Moreno (2012), this pattern is consistent with what is expected in young athletes at a stage of growth and development, where body composition tends to maintain low adiposity levels due to the combination of intensive training, high energy demands, and biological maturation. Previous studies (Bacciotti et al., 2017; Giorgi et al., 2025) in elite female artistic gymnasts have shown that, despite changes in height and bone mass, fat mass presents minimal variation throughout the season, reflecting training efficiency and energy adaptation to the demands of the sport. The stability of adiposity contributes to the optimization of performance and the maintenance of an anthropometric profile characteristic of the discipline.

Somatotype:

Regarding somatotype, the results show that during the general preparation phase (PRE), the gymnasts exhibited a predominantly mesomorphic pattern, with the majority located in the upper-central region of the somatochart, indicating low endomorphic, strong mesomorphic, and moderate ectomorphic components. These

findings are consistent with those of João and Fernández Filho (2015), who reported that elite artistic gymnasts presented an ecto-mesomorphic pattern characterized by low endomorphy and predominant mesomorphy. The mesomorphic component, associated with low relative adiposity and low subcutaneous fat content — which enhances the visibility of muscular contours — reflects high skeletal muscle development and volume, as well as larger bone diameters and joint dimensions.

During the pre-competitive phase (POST), a slight shift toward greater mesomorphy and a minor displacement toward endomorphy were observed. A similar study conducted with elite Italian artistic gymnasts (Massidda et al., 2013) described a somatotype combining endomorphy and mesomorphy, particularly in older age categories corresponding to the ages of the Spanish gymnasts in the present study (e.g., 1.7–4.2–2.7 in senior category), approximating a meso-endomorphic profile attributable to the early onset of gymnastics training coinciding with the final stages of pubertal development. In some gymnasts, the endomorphic component may be determined by their stage of biological development.

Somatotype stability was evident throughout the season. The absence of significant variation between both periods is consistent with findings reported by Marina (2008), who documented high somatotype stability across development in high-level gymnasts. Similarly, Irurtia Amigó et al. (2009) observed that in adolescents, despite growth in height and bone mass, the mesomorphic-ectomorphic profile remains relatively constant from adolescence to early adulthood.

Collectively, these results suggest that the pre-competitive phase induces structural adaptations compatible with training demands and biological development, while body composition and the somatotype characteristic of gymnasts remained relatively stable throughout the same season. This morphological stability may favor technical efficiency and sport-specific performance in artistic gymnastics.

Questionnaires:

The results obtained from the Mediterranean diet adherence questionnaire indicate that the gymnasts presented suboptimal adherence, falling below the values considered adequate in both the general preparation and pre-competitive phases. Although a trend toward improvement was observed during the pre-competitive phase, it was not sufficient to reach optimal levels. In this regard, similar suboptimal MD adherence values have been reported in other groups of young athletes, including kayakers (Alacid et al., 2014), swimmers (Philippou et al., 2017), female football players (González Neira et al., 2015), and elite futsal players (Rubio-Arias et al., 2015). However, the gymnasts in the present study differed from rhythmic gymnasts assessed by Peláez-Barrios & Vernetta (2022), who demonstrated optimal levels of MD adherence. Collectively, these findings suggest that, although adjustments in dietary patterns may occur through modifications in the prioritized intake of specific food groups (vegetables in the present case) as competition approaches, such changes were insufficient to generate meaningful improvements in adherence to the Mediterranean dietary model. Furthermore, a slight increase in the mean diet quality percentage (Diet Quality Index-International) was recorded during the pre-competitive phase. This increase may be related to the greater food consumption observed during this period, specifically the increased intake of protein, iron, and calcium through vegetable consumption.

A strong correlation was observed between diet quality and Mediterranean diet adherence, reinforcing the notion that greater adherence to this dietary pattern is associated with better dietary quality in gymnasts, consistent with previous findings reported by Vernetta Santana et al. (2021). Dietary habits constitute a dynamic and modifiable factor that significantly influences athletic performance, particularly in individual disciplines. They also play a determining role in body composition, considered an essential factor of physical performance. Therefore, it is important to recognize that, while diet alone does not determine maximum athletic performance, it constitutes a key factor contributing to the development and growth of gymnasts, and may significantly influence performance when adequately adjusted to the energy requirements of their sport (Vernetta, Mercedes, Montosa, Isabel, & López-Bedoya, 2018). Furthermore, Thomas et al. (2016) suggest that the improvement in dietary habits observed may be associated with greater nutritional attention during phases approaching competition, during which gymnasts tend to exert greater control over food intake and selection with the aim of optimizing performance and body composition before competing. This approach is consistent with the increase in mindful eating observed during the pre-competitive phase of the present study ($M = 2.83$).

Similarly, the level of mindful eating showed a slight increase from the general to the pre-competitive phase, without reaching statistical significance. This result may indicate greater nutritional awareness during pre-competitive stages, likely related to increased athletic demands and performance-related concerns. Other authors, Kabasakal and Satılmış (2024), found no association between mindful eating levels and the level of physical activity practice in young athletes, suggesting that physical training per se is not a determinant of improvements in the degree of mindful eating.

In contrast, Franco et al. (2016) demonstrated that exercise practice is associated with higher levels of attention and awareness during eating, as well as a lower tendency toward impulsive eating behavior. It is worth highlighting that Flores Becerra (2025) describes that many adolescent athletes require additional knowledge, skills, and support beyond their training in order to develop a healthy and sustained relationship with food.

Conclusions

The present study aimed to determine dietary composition, eating behavior, and body composition in a group of young female gymnasts across two consecutive competitive seasons.

Despite slight improvements observed between seasons, the dietary intake of the young gymnasts remained below the recommendations established for elite athletes. Furthermore, the guidelines associated with the Mediterranean dietary pattern were not met, which was reflected in their body composition and the regularity of their dietary habits. These results suggest limited nutritional knowledge, potentially influencing food selection and dietary planning.

Collectively, the findings underscore the need to implement systematic nutritional education and counseling strategies within the context of youth high-performance sport. In the case of gymnasts, the majority reside from a very early age in high-performance sports centers, where buffet-style dining is frequently available. In this setting, appropriate food selection is of great importance and constitutes a key determinant of dietary quality. Dietary interventions are therefore proposed, which should involve not only the gymnasts themselves, but also coaches, families, and sports institutions, to promote shared responsibility in the consolidation of adequate dietary habits that support healthy physical and mental development, self-care, and the optimization of athletic performance.

In conclusion, comprehensive nutritional support and healthy dietary habits constitute an essential component for optimizing physical development, health, and athletic performance, reinforcing self-care and well-being in a population of young and vulnerable female athletes competing at the highest level.

Limitations and Strengths

The primary limitation of the present study is the small sample size. However, given the high performance level of the athletes, recruiting large samples for this type of research is inherently challenging. The use of self-report questionnaires represents an additional limitation, as they may compromise the precision and validity of the dietary assessment method, particularly with regard to micronutrient intake estimation. Furthermore, no parameters were included to determine the degree of biological maturation of the gymnasts, including the monitoring of the menstrual cycle in adolescent gymnasts. Bone densitometry was not performed; therefore, bone mineral density data are not available. A further limitation is the absence of a matched control group of non-athletic peers of similar age.

The primary strength of the present study is the inclusion of exclusively elite gymnasts, all of whom are members of a team competing in national and international tournaments.

Conflicts of interest - We declare not having any conflict of interest with any of the aspects or results reported in the manuscript.

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