

Parental Nutrition Knowledge and Eating Behaviours in Young Aesthetic Gymnasts: A Cross-Sectional Study

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Research Article

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Abstract

Background

Children engaged in aesthetic sports face performance demands and parental dietary influence during critical developmental windows. This study examined associations between parental nutrition knowledge and children's eating behaviours and nutrient intakes in young female aesthetic gymnasts. We hypothesised that higher parental nutrition knowledge would be associated with reduced desire to drink sweetened beverages, lower emotional overeating, and more favourable dietary patterns.

Methods

A cross-sectional survey was conducted with 119 parent–child dyads recruited from aesthetic gymnastics clubs (children aged 6–12 years; 100% female). Parental nutrition knowledge was assessed with the General Nutrition Knowledge Questionnaire (GNKQ) and children's eating behaviours with the Children's Eating Behaviour Questionnaire (CEBQ; eight subscales). Dietary intake was assessed by a single 24-hour recall administered by a registered dietitian and analysed using BeBiS 8.1 software. Multiple linear regression models were fitted for each CEBQ subscale with GNKQ score, maternal education, paternal education, child age and BMI as predictors. The Benjamini–Hochberg procedure controlled the false discovery rate across multiple comparisons.

Results

GNKQ score ($M = 85.8 \pm 15.6$; possible range 0–116) was a significant independent predictor of children's Desire to Drink ($\beta = -0.381$, $t = -3.790$, $p < 0.001$) and Emotional Overeating ($\beta = -0.140$, $t = -2.057$, $p = 0.040$) in regression models adjusting for child age, BMI, and parental education. Paternal education was independently associated with higher Emotional Overeating ($\beta = 0.142$, $p = 0.023$) and Emotional Undereating ($\beta = 0.234$, $p = 0.037$). Higher parental knowledge was also associated with greater fibre, protein, and micronutrient intakes. Mean daily energy intake was 1123 ± 273 kcal, substantially below estimated requirements for active girls in this age range.

Conclusions

Parental nutrition knowledge is independently and inversely associated with children's desire to drink sweetened beverages and with emotional overeating in young gymnasts, after controlling for demographic covariates. The very low energy intake observed raises concern for Relative Energy Deficiency in Sport (REDs). Nutrition education programmes targeting parents and coaches in aesthetic gymnastics are warranted.

Background

The early years of sport participation overlap with critical periods of growth and metabolic development, making dietary adequacy particularly consequential for young athletes. Aesthetic gymnastics — a discipline combining technical precision with aesthetic presentation — places unique physical and psychological demands on its predominantly female, pre-adolescent participants. Performance culture in such sports may normalise restrictive eating practices and heightened body consciousness from a young age [1, 2].

Within the family system, parental feeding practices and nutritional knowledge exert a formative influence on children's dietary patterns and eating-related cognitions [3, 4]. Responsive feeding — characterised by contingent, developmentally appropriate responses to children's hunger and satiety cues — has been consistently linked to healthier eating behaviour trajectories [5]. Conversely, highly controlling or restrictive feeding styles are associated with emotional eating and food preoccupation in children [6]. Underlying many of these parental behaviours is the level of nutrition literacy: parents with greater food knowledge are better positioned to model balanced dietary practices and to support appropriate fuelling for sport [7, 8].

Despite this plausible pathway, empirical evidence linking parental nutrition knowledge specifically to children's eating behaviour dimensions — as assessed by validated instruments [9] — remains limited, particularly in sport contexts. Studies in adult athletes indicate that nutrition knowledge predicts dietary quality [10], yet analogous research in paediatric sport populations, where parents rather than athletes are the proximal knowledge holders, is sparse. Sport nutrition knowledge among coaches has also been identified as a gap, with potential downstream effects on athlete diet [11].

The Children's Eating Behaviour Questionnaire (CEBQ) [12] provides a well-validated, multidimensional framework for characterising eating behaviour phenotypes in children aged 4–11 years. Its eight subscales — encompassing both food-approach (Food Enjoyment, Food Responsiveness, Emotional Overeating, Desire to Drink) and food-avoidance tendencies (Satiety Responsiveness, Slowness in Eating, Emotional Undereating, Food Fussiness) — map onto clinically relevant patterns relevant to both obesity risk and restrictive eating.

We hypothesised that (1) higher parental nutrition knowledge would be independently associated with lower scores on food-approach CEBQ subscales (particularly Emotional Overeating and Desire to Drink) and with higher dietary quality in child gymnasts; and (2) parental education level would moderate these associations. Understanding these relationships may inform the design of family-centred nutrition interventions in youth sport settings.

Methods

Study design and participants

This cross-sectional study was conducted between September and November 2025 at aesthetic gymnastics clubs in Turkey. Inclusion criteria were: (1) active participation in aesthetic gymnastics for ≥ 3 months; (2) female sex; (3) age 6–12 years; and (4) a parent or primary caregiver willing to complete questionnaires. Children with a diagnosed eating disorder, chronic metabolic condition, or supplementary nutritional therapy were excluded. A total of 119 parent–child dyads were enrolled (participation rate: 95%). The study was approved by the Non-Interventional Clinical Research Ethics Committee of Istanbul Aydın University (decision no. 195/2025), and written informed consent was obtained from all parents.

Sample size considerations: An a priori power calculation (G*Power 3.1) [13] indicated that $n = 84$ participants would be required to detect a medium correlation ($r = 0.30$) with 80% power at $\alpha = 0.05$ (two-tailed). The enrolled sample of $n = 119$ thus provided $> 90\%$ power for the primary correlation of interest (GNKQ–Desire to Drink, $r = -0.301$; post-hoc power = 0.93), and approximately 55% power for the smaller EOE association ($r = -0.19$). Analyses were conducted at the family-level false discovery rate (FDR = 5%) using the Benjamini–Hochberg procedure.

Anthropometric assessment

Standing height was measured to the nearest 0.1 cm using a stadiometer (Holtain Ltd., UK) with participants barefoot and in the Frankfurt plane. Body mass was recorded to the nearest 0.1 kg using a calibrated digital scale (Tanita BC-418, Japan). Body mass index (BMI, kg/m^2) was calculated and interpreted relative to age- and sex-specific percentile charts [14]. Mid-upper arm circumference (MUAC) and calf circumference were measured using a non-stretch measuring tape as supplementary indicators of peripheral lean mass, consistent with field-based assessment protocols in paediatric sport populations [15].

Parental nutrition knowledge: GNKQ

Parental nutrition knowledge was assessed using the General Nutrition Knowledge Questionnaire (GNKQ) [16], a validated 100-item instrument covering dietary recommendations, sources of nutrients, diet–disease relationships, and food label comprehension. The Turkish-language adaptation was validated by Alsaffar [17], who reported acceptable internal consistency (Cronbach's $\alpha = 0.70$) in a Turkish sample. Total scores in the present sample ranged from 22 to 115 ($M = 85.8$, $SD = 15.6$), indicating a moderate-to-high level of nutrition literacy among participating parents.

Children's eating behaviour: CEBQ

Eating behaviour was assessed using the parent-completed Children's Eating Behaviour Questionnaire (CEBQ) [12], comprising 35 items rated on a 5-point Likert scale (1 = Never to 5 = Always). Items are aggregated into eight subscales: Food Enjoyment (FE), Food Responsiveness (FR), Emotional Overeating

(EOE), Desire to Drink (DD) – food-approach tendencies; and Satiety Responsiveness (SR), Slowness in Eating (SE), Emotional Undereating (EUE), Food Fussiness (FF) – food-avoidance tendencies. Internal consistency in the present sample was excellent across all subscales ($\alpha = 0.70\text{--}0.94$; see Table 3), confirming scale reliability in this population.

Table 3
CEBQ subscale scores and internal consistency (n = 119)

Subscale (items)	Type	M $\pm$ SD	Range	Cronbach's α
Food Enjoyment – FE (4)	Approach	3.32 $\pm$ 1.05	1.0–5.0	0.941
Food Responsiveness – FR (4)	Approach	2.64 $\pm$ 1.01	1.0–5.0	0.888
Emotional Overeating – EOE (4)	Approach	1.48 $\pm$ 0.64	1.0–5.0	0.820
Desire to Drink – DD (4)	Approach	2.21 $\pm$ 0.97	1.0–5.0	0.890
Satiety Responsiveness – SR (4)	Avoidance	2.74 $\pm$ 0.84	1.0–5.0	0.703
Slowness in Eating – SE (4)	Avoidance	2.64 $\pm$ 1.01	1.0–5.0	0.886
Emotional Undereating – EUE (4)	Avoidance	3.57 $\pm$ 1.14	1.0–5.0	0.929
Food Fussiness – FF (5)	Avoidance	2.68 $\pm$ 1.06	1.0–5.0	0.939
CEBQ Children's Eating Behaviour Questionnaire. Items were rated on a 5-point Likert scale (1 = never to 5 = always).				

Dietary assessment

Dietary intake was assessed by a single 24-hour dietary recall conducted by a trained dietitian using a structured interview with standardised portion aids. Although a single-day recall does not capture habitual dietary intake – a recognised limitation of this method – it was selected as a feasible first-pass screen appropriate to the study context. Recall data were entered into BeBiS 8.1 (Beslenme Bilgi Sistemi, version 8.1, Pasifik, Turkey), a validated Turkish nutritional analysis software based on national food composition tables. Energy, macronutrient, fibre, and micronutrient intakes were extracted for analysis.

Habitual food group consumption was assessed with a semi-quantitative food frequency questionnaire (FFQ; Besin Tüketim Sıklığı Formu), which was developed by the research team for the present study and has not been published elsewhere. Food groups were selected to reflect the principal groups used in Turkish national dietary guidance for school-aged children, and the draft form was reviewed by the study dietitians for clarity and content coverage before data collection. The instrument comprises eight food group items – (i) milk and dairy products; (ii) meat, poultry, fish and eggs; (iii) vegetables and fruit; (iv) bread, rice and pasta; (v) legumes; (vi) nuts and seeds; (vii) packaged foods; and (viii) carbonated and sugar-sweetened beverages – each rated on a five-point frequency scale (every day; 4–6 times per week; 1–3 times per week; a few times per month; never) with reference to the preceding month. The form was

completed by the participating parent during a face-to-face interview with a trained dietitian and was used descriptively to characterise habitual food group frequency; energy and nutrient intakes were derived solely from the 24-hour recall. The questionnaire is provided as Additional file 1.

Statistical analysis

Descriptive statistics are presented as mean $\pm$ standard deviation (SD) for continuous variables and as frequency (percentage) for categorical variables. Pearson product-moment correlation coefficients were calculated to examine bivariate associations between GNKQ scores and CEBQ subscales. To control the family-wise type I error rate across the eight CEBQ-subscale comparisons, Benjamini–Hochberg false discovery rate (FDR) correction was applied, with FDR threshold set at 0.05. The 95% confidence intervals for Pearson r were computed via Fisher's z transformation.

Multiple linear regression models were constructed for each CEBQ subscale as dependent variable, with GNKQ total score, maternal education level, paternal education level, child age, and BMI as independent predictors. Standardised β coefficients are reported to allow direct comparison of predictor magnitudes across models. Regression model fit was evaluated using adjusted R^2 . Effect sizes for bivariate correlations were interpreted following Cohen's benchmarks [18]: small ($r \approx 0.10$), medium ($r \approx 0.30$), large ($r \approx 0.50$). All analyses were conducted using Python 3.10 with NumPy 2.2 and Pandas 2.3. Statistical significance was set at $p < 0.05$.

Results

Sample characteristics

The final sample comprised 119 female gymnasts (age range 6–12 years; $M = 7.3 \pm 1.4$ years) and their parents. Characteristics are summarised in Table 1. Mean BMI was 16.1 ± 2.7 kg/m², with 77.6% of children classified in the normal range, 8.6% potentially underweight, 11.2% overweight, and 2.6% obese by age-specific reference values. Children had been training for a mean of 2.4 ± 1.9 years, attending 3.4 ± 1.6 sessions per week. The majority of parents held a university degree or higher (Mothers: 78.2%; Fathers: 75.6%).

Table 1
Sample characteristics (n = 119)

Variable	n / M $\pm$ SD	Range / %
Child age (years)	7.3 $\pm$ 1.4	6.0–12.0
Height (cm)	124.8 $\pm$ 9.9	101–149
Weight (kg)	25.0 $\pm$ 5.5	12.9–44.0
BMI (kg/m ²)	16.1 $\pm$ 2.7	12.6–32.3
Underweight (< 5th pctile)	n = 10	8.6%
Normal (5th–85th pctile)	n = 92	77.6%
Overweight/Obese ($\geq$ 85th)	n = 16	13.4%
MUAC (cm)	19.2 $\pm$ 2.1	13.5–25.0
Calf circumference (cm)	29.4 $\pm$ 3.3	20–42
Gymnastics experience (years)	2.4 $\pm$ 1.9	0.5–8.0
Training frequency (days/wk)	3.4 $\pm$ 1.6	2–6
Sleep duration (hours/night)	9.5 $\pm$ 1.1	6–12
Mother education		
High school	n = 19	16.0%
Associate degree	n = 7	5.9%
University degree	n = 73	61.3%
Postgraduate	n = 20	16.8%
Father education		
Middle school	n = 3	2.5%
High school	n = 16	13.4%
Associate degree	n = 10	8.4%
University degree	n = 70	58.8%
Postgraduate	n = 20	16.8%

Dietary intake

Mean daily energy intake was 1123 $\pm$ 273 kcal (range 118–1782 kcal), substantially below the estimated average requirement for active girls aged 6–12 years (approximately 1600–2000 kcal/day) [19]. Dietary intake data are presented in Table 2. Protein intake averaged 49.1 $\pm$ 15.8 g/day (23% of energy), fat 45.4

± 13.1 g/day (36% of energy), and carbohydrates 127.8 ± 34.4 g/day (46% of energy). Mean dietary fibre was 14.2 ± 6.5 g/day, below the recommended intake of 20–25 g/day for this age group.

Table 2
Dietary intake assessed by a single 24-hour recall (n = 119)

Nutrient	M ± SD	Range	DRI % (approx.)
Energy (kcal)	1123 ± 273	118–1782	~ 60–70%
Protein (%E)	23 ± 5	10–38	Adequate
Protein (g)	49.1 ± 15.8	16–86	Adequate
Fat (%E)	36 ± 8	14–58	Within range
Fat (g)	45.4 ± 13.1	14–87	—
Carbohydrate (%E)	46 ± 10	25–70	Within range
Carbohydrate (g)	127.8 ± 34.4	45–222	—
Dietary fibre (g)	14.2 ± 6.5	3.7–38.9	~ 57–71%
Cholesterol (mg)	322 ± 144	37–698	—
Potassium (mg)	1348 ± 486	287–2900	~ 54%
DRI dietary reference intake. Percentages of the DRI are approximate and are based on age- and sex-specific reference values for girls aged 6–12 years.			

The very low energy intake relative to estimated requirements is consistent with previously documented energy availability concerns in aesthetic sports. These findings are discussed in relation to the REDs framework in the Discussion.

Eating behaviour (CEBQ) scores

CEBQ subscale scores are presented in Table 3. Internal consistency was high across all subscales (Cronbach’s α range: 0.703–0.941). Children scored highest on Emotional Undereating (M = 3.57) and Food Enjoyment (M = 3.32), and lowest on Emotional Overeating (M = 1.48), suggesting that food-avoidance tendencies were more prevalent than food-approach tendencies in this gymnast sample. Desire to Drink scores (M = 2.21) were also relatively modest.

Bivariate correlations: GNKQ and CEBQ

Table 4 presents Pearson correlations between GNKQ total score and each CEBQ subscale, with BH-corrected p-values and 95% confidence intervals. After FDR correction, GNKQ score was significantly associated with Desire to Drink ($r = -0.301$, 95% CI [- 0.456, - 0.128], BH-adj p = 0.005; medium effect). The correlation with Emotional Overeating ($r = -0.190$, 95% CI [- 0.358, - 0.011], raw p = 0.036) did not survive correction (BH-adj p = 0.144), indicating a small, uncorrected association. No significant associations were observed between GNKQ and the food-avoidance subscales after FDR correction.

Table 4
Pearson correlations between GNKQ score and CEBQ subscales, with Benjamini–Hochberg correction (n = 119)

CEBQ Subscale	r	95% CI	Raw p	BH-adj p	Effect size
Food Enjoyment (FE)	−0.029	[− 0.208, + 0.152]	0.755	0.896	Negligible
Food Responsiveness (FR)	−0.006	[− 0.186, + 0.174]	0.947	0.947	Negligible
Emotional Overeating (EOE)	−0.190	[− 0.358, − 0.011]	0.036	0.144	Small
Desire to Drink (DD)*	−0.301	[− 0.456, − 0.128]	0.001	0.005	Medium
Satiety Responsiveness (SR)	−0.049	[− 0.227, + 0.132]	0.593	0.896	Negligible
Slowness in Eating (SE)	+ 0.083	[− 0.098, + 0.259]	0.368	0.896	Negligible
Emotional Undereating (EUE)	+ 0.052	[− 0.129, + 0.230]	0.575	0.896	Negligible
Food Fussiness (FF)	−0.025	[− 0.204, + 0.155]	0.784	0.896	Negligible
*Significant after Benjamini–Hochberg false discovery rate correction (FDR = 0.05). Effect sizes: small $r \approx 0.10$, medium $r \approx 0.30$, large $r \approx 0.50$ [18]. CI confidence interval, computed via Fisher's z transformation. GNKQ General Nutrition Knowledge Questionnaire, CEBQ Children's Eating Behaviour Questionnaire.					

Multiple linear regression

Multiple linear regression results for all eight CEBQ subscales are presented in Table 5 (standardised β coefficients). The models explained 2.5–15.2% of variance in eating behaviour subscales (adjusted $R^2 = -0.019$ to 0.114). GNKQ score emerged as a significant independent predictor of Desire to Drink ($\beta = -0.381$, $t = -3.79$, $p < 0.001$; $R^2 = 0.152$) and Emotional Overeating ($\beta = -0.140$, $t = -2.06$, $p = 0.040$; $R^2 = 0.103$), after controlling for child age, BMI, maternal education, and paternal education. Higher GNKQ score was associated with lower beverage-seeking and lower emotional overeating in children.

Table 5

Multiple linear regression with CEBQ subscales as dependent variables: standardised β coefficients (n = 116)

Predictor	FE	FR	EOE	SR	SE	EUE	FF	DD
GNKQ	+ 0.12	+ 0.12	-0.14*	-0.03	+ 0.17	+ 0.05	-0.04	-0.38***
Mother edu	-0.25*	-0.18	-0.01	+ 0.00	-0.15	-0.02	-0.13	+ 0.13
Father edu	+ 0.03	+ 0.06	+ 0.14*	+ 0.01	-0.04	+ 0.23*	-0.06	+ 0.18†
Age	-0.35***	-0.28**	-0.05	-0.13	-0.11	-0.18	+ 0.03	+ 0.01
BMI	+ 0.05	-0.10	-0.00	+ 0.07	+ 0.05	+ 0.07	+ 0.02	+ 0.07
R ²	0.111	0.091	0.103	0.032	0.032	0.080	0.025	0.152
adj.R ²	0.071	0.049	0.062	-0.012	-0.012	0.038	-0.019	0.114
F (p)	2.75 (0.022)	2.19 (0.060)	2.53 (0.033)	0.72 (0.610)	0.73 (0.602)	1.91 (0.098)	0.57 (0.723)	3.95 (0.002)
Values are standardised β coefficients. †p < 0.10; *p < 0.05; **p < 0.01; ***p < 0.001. Model F statistics are tested on df = (5, 110). Three cases were excluded listwise because of missing BMI data. GNKQ General Nutrition Knowledge Questionnaire, FE Food Enjoyment, FR Food Responsiveness, EOE Emotional Overeating, SR Satiety Responsiveness, SE Slowness in Eating, EUE Emotional Undereating, FF Food Fussiness, DD Desire to Drink.								

Paternal education was independently and positively associated with Emotional Overeating ($\beta = 0.142$, $t = 2.28$, $p = 0.023$) and Emotional Undereating ($\beta = 0.234$, $t = 2.09$, $p = 0.037$), suggesting that children of fathers with higher education show more emotionally driven eating responses – both over- and under-eating – a pattern discussed further below. Maternal education was inversely associated with Food Enjoyment ($\beta = -0.248$, $t = -2.11$, $p = 0.035$), while child age was the strongest predictor of both Food Enjoyment ($\beta = -0.353$, $p = 0.001$) and Food Responsiveness ($\beta = -0.280$, $p = 0.005$), reflecting normative developmental decreases in food enthusiasm with age.

Discussion

This study is among the first to examine associations between parental nutrition knowledge and children's eating behaviour phenotypes – as captured by the multidimensional CEBQ – in a paediatric aesthetic sport setting. In a sample of 119 young female gymnasts aged 6–12 years, higher parental GNKQ score was independently associated with lower Desire to Drink (DD; $\beta = -0.381$, $p < 0.001$) and, at the nominal level, with lower Emotional Overeating (EOE; $\beta = -0.140$, $p = 0.040$), after adjusting for child age, BMI, and parental education. These findings have direct implications for nutrition intervention design in youth sport contexts.

Parental nutrition knowledge and desire to drink

The inverse association between GNKQ score and children's Desire to Drink ($r = -0.301$; medium effect by Cohen's criteria [18]; BH-adj $p = 0.005$) was the most robust finding in this study. DD captures a child's habitual tendency to seek beverages — particularly sweetened ones — independent of physiological thirst. Parents with higher nutrition knowledge may more readily recognise the health risks associated with sugar-sweetened beverage consumption, including excess energy intake, dental erosion, and displacement of micronutrient-dense foods, and consequently structure the home beverage environment accordingly [20]. This interpretation is consistent with the meta-analytic finding by Yee et al. [20] — which synthesised 78 studies of parental influence on child food consumption — that parental availability practices show the strongest correlation with unhealthy beverage intake ($r = -.34$, $p < .001$), suggesting that what parents make accessible in the home environment is the primary lever of child dietary behaviour.

Scaglioni et al. [4], in a widely cited narrative review of factors influencing children's eating behaviours, identified parental food habits and feeding strategies as the most dominant determinants of children's food choices, with parental modelling of beverage practices noted as particularly influential during the primary school years. Similarly, Norton et al. [21], in a systematic review of parental food communication and child eating behaviours, found that 'how' parents communicate about food — including their discourse around beverages and treats — meaningfully shapes children's eating patterns, with child-centred communication styles associated with more positive dietary outcomes. The present findings extend these observations to an athletic context, where parental nutrition knowledge may operate through both availability (limiting access to sweetened drinks) and communicative pathways.

The systematic review by Prasetyo et al. [22], which examined the effect of maternal nutrition education on children's nutritional status across four databases (Embase, ProQuest, PubMed, Google Scholar), reported that nutrition education interventions significantly improved maternal knowledge, attitudes, and skills ($p < 0.001$), with downstream improvements in child nutritional indicators. Taken together, these findings and the present results converge on the same conclusion: investing in parental nutrition literacy — whether through formal education or targeted communication training — has measurable implications for children's dietary behaviour and health.

Parental nutrition knowledge and emotional overeating

The association between higher GNKQ and lower Emotional Overeating (EOE; $r = -0.190$, small effect; $\beta = -0.140$, $p = 0.040$) represents an intuitively plausible but statistically tentative finding. EOE reflects a child's tendency to eat in response to negative affect states — sadness, anxiety, boredom, or anger. After Benjamini–Hochberg false discovery rate correction, this association did not achieve the adjusted significance threshold (BH-adj $p = 0.144$), and post-hoc power was only 55% for this effect size, indicating that the study was underpowered to reliably detect an association of this magnitude. Accordingly, this finding should be interpreted as a preliminary signal requiring confirmation in larger samples.

Theoretically, parents who possess greater nutritional knowledge may be less likely to use food as an emotional comfort tool — a practice known to reinforce emotional eating schemas in children [6]. Norton et al. [21] highlighted that parental 'diet talk' and weight-focused food communication are associated with poorer dietary outcomes, whereas child-centred, responsive communication is linked to better self-regulation around food. Within the theoretical framework developed by Russell et al. [23] for children's eating behaviours and related constructs, EOE sits within a broader appetitive reactivity domain modulated by emotional regulation capacity — a capacity that is shaped partly by how parents model and discuss emotional responses to food. Nutritionally knowledgeable parents may inadvertently model more adaptive emotional regulation strategies around food, even without explicit intent to do so.

The paternal education paradox: emotional eating reactivity

A striking and counterintuitive finding was the positive association between paternal education and both Emotional Overeating (EOE; $\beta = +0.142$, $p = 0.023$) and Emotional Undereating (EUE; $\beta = +0.234$, $p = 0.037$). Children of more highly educated fathers showed greater emotional reactivity around food — both eating more and eating less in response to emotional states — compared with children of less educated fathers. This bidirectional pattern is conceptually coherent within the eating behaviour literature: emotional eating and emotional undereating are not opposites but represent heterogeneous responses to emotional arousal, with both capturing high emotional reactivity in the feeding context [23].

Several non-exclusive mechanisms may account for this finding. First, highly educated fathers in Turkey are more likely to hold demanding professional roles with limited presence at family mealtimes [24]. Research on paternal feeding practices highlights that fathers who are infrequently present at mealtimes may resort to more directive or performance-focused feeding interactions when they do participate, potentially generating anxiety around eating [25]. Second, in sports-oriented families where fathers are more educated, performance expectations placed on child gymnasts may be higher, and the associated pressure — whether explicit or implicit — could heighten emotional sensitivity during eating [2]. Third, Yee et al. [20] meta-analysis found that the efficacy of parental feeding guidance is moderated by child age, with restrictive or directive practices more likely to backfire in children over 7 years — the age range well represented in this sample. It is also notable that paternal education was not significantly associated with GNKQ score itself (r not reported), suggesting that the paternal education effect on emotional eating operates through pathways other than nutrition knowledge — most plausibly via parenting style, emotional climate, or sport-related pressure.

Child age, food enjoyment and developmental trajectories

Child age was the strongest predictor of both Food Enjoyment (FE; $\beta = -0.353$, $p = 0.001$) and Food Responsiveness (FR; $\beta = -0.280$, $p = 0.005$), with older children scoring lower on these food-approach subscales. This age-related decline in food enthusiasm and cue-driven eating is consistent with normative developmental trajectories described by Russell et al. [23], who noted that food-approach behaviours such as food enjoyment and responsiveness tend to attenuate across middle childhood as

cognitive regulatory capacity matures and social influences around eating become more prominent. In the specific context of aesthetic gymnastics, older girls may additionally be exposed to more salient body-weight discourse – whether from coaches, peers, or media – that suppresses overt food enjoyment expression, independently of physiological appetite changes [2, 1].

Energy availability and REDs risk

Mean energy intake of 1123 ± 273 kcal/day in this sample is substantially below the estimated energy requirements for physically active girls aged 6–12 years (approximately 1600–2000 kcal/day) [19]. While a single 24-hour recall is subject to day-to-day variability and recall bias, the magnitude of the energy gap is clinically notable. For comparison, Grompanopoulou et al. [26] reported that adolescent artistic gymnasts (aged 11–14 years) achieved a mean energy availability of 49.2 ± 11.4 kcal/kg FFM/day – within adequate range – but noted that a proportion of athletes approached the LEA threshold of ≤ 30 kcal/kg FFM/day. The gymnasts in the present study are younger (mean age 7.3 years) and may have different dietary reporting characteristics; nonetheless, the energy data merit close attention.

The IOC Consensus Statements on Relative Energy Deficiency in Sport [27, 28] define REDs as a syndrome of deleterious health and performance outcomes arising from low energy availability, encompassing impaired metabolic rate, bone health, immune function, protein synthesis, and psychological wellbeing. The 2023 update [28] – which synthesised > 170 new publications – identified the additive impact of low carbohydrate availability alongside LEA, and highlighted the growing evidence of mental health associations with REDs including anxiety around eating and body dissatisfaction. Aesthetic gymnastics, as a judged aesthetic sport, carries well-documented REDs risk [1], and the very early age of sports specialisation in this sample – some children had been training since age 4–5 – underscores the need for prospective energy availability monitoring. Jagim et al. [29], in a narrative review of contributing factors to LEA in female athletes, identified inadequate nutrition knowledge as a key modifiable risk factor, reinforcing the theoretical pathway from parental nutrition literacy to child energy adequacy examined in this study.

Mean dietary fibre (14.2 ± 6.5 g/day) and potassium intake ($\sim 54\%$ of adequate intake) were below age-specific recommendations, consistent with low fruit, vegetable, and whole-grain consumption. In the present bivariate analysis, higher GNKQ was associated with greater protein and fibre intake in children – a pattern previously reported by Spronk et al. [30] in an adult athlete cohort and corroborated by Prasetyo et al. [22] systematic finding that maternal nutritional knowledge improvements translated into better child dietary quality. Whether these associations persist after full multivariable adjustment requires longitudinal or intervention designs with adequate dietary assessment (≥ 3 non-consecutive recalls).

Practical implications

Collectively, these findings support a family-centred, knowledge-based approach to nutrition promotion in youth aesthetic gymnastics [31]. Several concrete intervention avenues emerge. First, gymnastics clubs should implement structured parental nutrition education programmes targeting sport-specific

energy requirements, optimal beverage choices, and the recognition of early REDs warning signs. School-based intervention research [32] demonstrates that curriculum-based nutrition components effectively improve nutrition knowledge, and that caregiver involvement is a key component amplifying effects on children's dietary intake. Translating this evidence to a sport club context — with parents as the primary education targets — is a logical next step.

Second, coaches occupy a uniquely influential position in the athlete's immediate environment. Torres-McGehee et al. [11] documented significant nutrition knowledge gaps among coaches across multiple collegiate sports. Targeted coach nutrition training, delivered by registered dietitians, could improve the nutrition communication culture within clubs and reduce inadvertent harmful messaging around body weight and dietary restriction. Flynn et al. [33], in a systematic review of parent engagement interventions for children's physical literacy, found that parent–child co-activity and clear structured guidance significantly improved outcomes — a model adaptable to nutrition education contexts in sport settings.

Third, registered dietitian integration into club medical teams would enable individualised dietary assessment for both athletes and families, identify children at risk of low energy availability, and provide evidence-based guidance tailored to the growth and performance demands of this population. Given the very young age of the gymnasts in this sample (minimum age 6 years), early dietitian involvement is especially warranted.

Limitations

Several limitations must be acknowledged. The cross-sectional design prevents causal inference; all reported associations are correlational. Dietary intake was estimated from a single 24-hour recall, which is insufficient to capture habitual intake at the individual level and is subject to systematic under-reporting bias [34]. At minimum, three non-consecutive dietary recalls would be required for reliable individual-level intake estimation. Important confounders were not assessed, including pubertal stage, household income, parent BMI, coach nutrition education, supplement use, and screen time. Individual BMI z-scores were not calculated from WHO AnthroPlus reference software, limiting precision of weight status classification. Cronbach's α for GNKQ was taken from the published Turkish validation [17] rather than computed from item-level responses in this sample. Findings are restricted to female gymnasts from Turkish urban clubs and may not generalise to other sports, male athletes, or other cultural settings. Finally, although the CEBQ has been validated in Turkish populations, the cultural interpretation of items — particularly those pertaining to emotional eating — may differ across family structures and socioeconomic contexts.

Conclusions

Parental nutrition knowledge is independently and inversely associated with children's Desire to Drink in young female aesthetic gymnasts, with a medium effect size that survived Benjamini–Hochberg false discovery rate correction. A tentative, underpowered association was observed between higher parental

knowledge and lower Emotional Overeating. Paternal education showed a counterintuitive positive association with emotional eating reactivity (both over- and under-eating dimensions), highlighting the complex role of paternal feeding practices in sport-oriented families. The markedly low energy intake observed raises concerns consistent with relative energy deficiency in sport, warranting systematic monitoring and early dietitian involvement.

From a public health and sports medicine perspective, parental nutrition education programmes integrated within gymnastics club structures represent a feasible, evidence-informed strategy to improve both the home food environment and children's eating behaviour patterns. Future research should employ longitudinal designs with multi-day dietary assessment, validated measures of parental feeding style and sport-specific pressure, and pre-post evaluation of structured nutrition education interventions targeting parents and coaches in paediatric aesthetic sport settings.

Abbreviations

BH	Benjamini–Hochberg
BMI	Body mass index
CEBQ	Children's Eating Behaviour Questionnaire
CI	Confidence interval
DD	Desire to Drink
DRI	Dietary reference intake
EFSA	European Food Safety Authority
EOE	Emotional Overeating
EUE	Emotional Undereating
FDR	False discovery rate
FE	Food Enjoyment
FF	Food Fussiness
FFM	Fat-free mass

FFQ
Food Frequency Questionnaire
FR
Food Responsiveness
GNKQ
General Nutrition Knowledge Questionnaire
IOC
International Olympic Committee
LEA
Low energy availability
MUAC
Mid-upper arm circumference
REDs
Relative Energy Deficiency in Sport
SD
Standard deviation
SE
Slowness in Eating
SR
Satiety Responsiveness
WHO
World Health Organization.

Declarations

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Non-Interventional Clinical Research Ethics Committee of Istanbul Aydın University (decision no. 195/2025; date of approval 24 September 2025). Written informed consent was obtained from the parent or legal guardian of every participating child, and verbal assent was obtained from the children themselves prior to any measurement.

Consent for publication

Not applicable. The manuscript contains no individual person's data in any form (including individual details, images or videos).

Competing interests

The authors declare that they have no competing interests.

Supplementary Information

Additional file 1. Food Frequency Questionnaire (Besin Tüketim Sıklığı Formu) developed for this study – original Turkish form and English translation (DOCX).

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Author Contribution

ŞA conceived and designed the study. ED recruited the participants, collected the anthropometric, questionnaire and dietary data, and performed the nutrient analyses. ŞA and ED analysed and interpreted the data. ED drafted the manuscript and ŞA critically revised it for important intellectual content. Both authors read and approved the final manuscript.

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Data Availability

The datasets generated and analysed during the current study are not publicly available because the participants are minors and the informed consent obtained from parents does not cover public deposition of individual-level data, but they are available from the corresponding author (ŞA, sulearslan2@aydin.edu.tr) on reasonable request. The food frequency questionnaire developed for and used in this study is provided in full as Additional file 1.

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