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Eating Disorders in Female Gymnasts: Cultural Pressures and Psychological Interventions

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A B S T R A C T

This study evaluated the efficacy of cognitive-behavioral interventions, particularly graded exposure therapy, in addressing fear of re-injury among athletes following anterior cruciate ligament (ACL) reconstruction, comparing outcomes with traditional cognitive restructuring and standard rehabilitation approaches. A randomized controlled trial was conducted with 120 athletes (ages 16-25) at 3-6 months post-ACL reconstruction, randomly assigned to graded exposure (GE), cognitive restructuring (CR), or standard care (SC) groups. The GE protocol incorporated systematic desensitization through sport-specific movements, while CR focused on modifying maladaptive beliefs about re-injury. Primary outcomes included changes in Tampa Scale for Kinesiophobia (TSK-11) scores, biomechanical assessments during drop-jump tasks, and return-to-sport rates, measured at baseline, 6, 12, and 24 weeks. The GE group demonstrated superior outcomes, with a 35.3% reduction in fear scores (TSK-11) compared to 33.1% in CR and 22.7% in SC ($p < 0.001$). Biomechanical improvements, including knee flexion angle and limb symmetry, were significantly greater in GE ($p < 0.001$). Qualitative findings highlighted enhanced movement confidence and reduced somatic fear in GE participants. Return-to-sport rates were highest in GE (68.9%) versus CR (62.5%) and SC (45.0%) ($p = 0.007$). Graded exposure therapy emerges as the most effective intervention for reducing fear of re-injury post-ACLR, combining psychological and neuromuscular benefits. These findings support integrating exposure-based protocols into standard rehabilitation programs during early-to-mid recovery phases to optimize both physical and psychological readiness for return to sport.

Keywords: *ACL reconstruction, fear of re-injury, cognitive-behavioral therapy, graded exposure, return to sport*

1. Introduction

Eating disorders (EDs) represent a significant public health and sport-specific concern, particularly within aesthetic sports such as gymnastics, where the intersection of performance demands, cultural ideals, and body image pressures creates an environment highly conducive to disordered eating behaviors (1, 2). Elite female athletes face ED prevalence rates far exceeding those of the general population, with systematic reviews estimating risk levels two to three times higher in sport-specific samples (3, 4). Within gymnastics, the cultural ideal of leanness is often

framed as a prerequisite for success, reinforced through judging criteria, media portrayal, and interpersonal feedback from coaches and peers (5, 6). This persistent thinness norm, combined with intensive training schedules and weight-sensitive performance evaluation, can accelerate the onset and maintenance of ED pathology (7, 8).

The risk is compounded by the dual pressures of sport-specific performance goals and broader sociocultural standards of attractiveness. Research shows that athletes in leanness-focused disciplines such as gymnastics, ballet, and figure skating are more susceptible to internalizing a performance-aesthetic identity, where body shape becomes a proxy for both competitive and social worth (9, 10). This identity is further shaped by perfectionism, a trait that has been consistently associated with higher ED symptom severity in athletes (11, 12). Perfectionism in sport often manifests through rigid dietary control and compulsive training, behaviors that may initially be rewarded by short-term performance gains but ultimately undermine both physical and psychological health (13, 14).

Body dissatisfaction emerges as a central mediator in the pathway from cultural pressures to ED symptomatology (15, 16). Studies across various sports confirm that athletes who perceive a mismatch between their current body and the sport's idealized physique are more likely to engage in restrictive eating, purging, or excessive exercise (17, 18). In gymnastics, these pressures are magnified by the visibility of the athlete's body during performance and the weight-sensitive scoring environment (19, 20). This dynamic is especially problematic for adolescent athletes, whose developmental stage makes them more vulnerable to internalizing critical feedback (21, 22).

Coach behavior is consistently identified as one of the most powerful environmental influences on ED risk (6, 23). While supportive coaching can buffer against sociocultural pressures, weight-focused commentary, public weigh-ins, and implicit linking of leanness with success can drive maladaptive eating behaviors (8, 24). In some cases, the coach–athlete relationship becomes a conduit for perfectionistic reinforcement, where athletes feel valued primarily for their compliance with weight-related expectations (25, 26). Given the hierarchical and trust-based nature of this relationship, harmful weight practices from coaches can have disproportionate psychological impact, fostering long-term body dissatisfaction and anxiety (5, 6).

Beyond the gym environment, digital and social media platforms amplify appearance pressures. Social comparison theory suggests that constant exposure to idealized images of athletes—both peers and celebrities—fuels dissatisfaction and unhealthy weight-control strategies (16, 27). Studies have shown that Instagram usage is associated with lower body satisfaction and self-esteem among young women (28, 29), and that these effects can be especially pronounced in athletes who use the platform for performance self-promotion (15). The combination of in-person sport culture and online social pressures can therefore create a continuous loop of body surveillance and weight monitoring (4, 12).

Although screening tools for ED risk in athletes have advanced (30, 31), their application in gymnastics remains inconsistent, and many athletes remain undiagnosed until symptoms become severe. This underdiagnosis is partly due to the normalization of extreme weight-control practices in sport, which can mask clinical symptoms (32, 33). Additionally, athletes often underreport symptoms out of fear of losing their competitive status (14, 26).

Intervention research highlights the limitations of traditional approaches adapted from general ED populations. Cognitive-behavioral therapy (CBT) has been effective in community samples but shows mixed results in athlete populations, possibly due to its limited focus on sport-specific stressors (7, 13). The International Olympic Committee's consensus statements on Relative Energy Deficiency in Sport (RED-S) emphasize the need for multidisciplinary, performance-integrated interventions (19, 20). Acceptance and Commitment Therapy (ACT) has emerged as a promising alternative, with evidence suggesting its effectiveness in enhancing psychological flexibility, reducing body dissatisfaction, and improving well-being in athletes (12, 34). ACT's focus on values-based action rather than weight outcomes may be particularly appealing in elite sport contexts, where performance goals are paramount (4, 6).

ACT's potential lies in its dual capacity to target both the emotional regulation difficulties that underlie ED behaviors and the sport-specific cognitive patterns that perpetuate them (1, 25). For gymnasts, who face unique demands for precision, discipline, and public aesthetic display, this

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approach may bridge the gap between psychological health and competitive readiness (2, 5). Recent trials in sport settings show that ACT can reduce disordered eating symptoms while maintaining or even enhancing performance (4, 34). These findings support the integration of ACT into sport-specific prevention and treatment protocols, ideally alongside coach education and policy reforms aimed at reducing harmful weight-related practices (7, 23).

Despite these advances, gaps remain in understanding how ACT can be optimally adapted to the gymnastics context, particularly in addressing the interplay between cultural pressures, coach influence, and athlete psychological resilience (6, 35). Furthermore, the literature lacks longitudinal evaluations of ACT's sustained impact across different competitive levels and transition phases, such as retirement (13, 26).

Building on these gaps, the present study examines the prevalence of eating disorders among elite female gymnasts, with particular focus on the role of coach-related and cultural pressures in shaping ED risk.

2. Methods and Materials

2.1. Study Design and Participants

This study employed a mixed-methods sequential explanatory design, integrating quantitative and qualitative approaches to comprehensively examine the interplay between cultural pressures and psychological interventions in female gymnasts with eating disorders (EDs). The first phase consisted of a cross-sectional survey assessing the prevalence of EDs, body image concerns, and psychological distress among competitive female gymnasts. The second phase involved in-depth semi-structured interviews with a subset of participants to explore their lived experiences, perceptions of cultural pressures, and responses to psychological interventions. This dual-phase design was selected to provide both broad statistical trends and nuanced contextual insights, aligning with recent recommendations for ED research in athletic populations.

A total of 350 elite female gymnasts, aged 15–30 years, were recruited from national gymnastics federations and competitive clubs across Norway. Participants were eligible if they had competed at regional, national, or international levels within the past two years. Exclusion criteria included a history of non-sport-related psychiatric hospitalization or current involvement in another structured ED treatment program. The sample size was determined based on a priori power analysis (G*Power 3.1), indicating that 300 participants would provide 80% power to detect medium effect sizes (Cohen's $f = 0.25$) in multivariate analyses.

Demographic characteristics revealed a mean age of 19.4 years (±3.2), with 62% specializing in artistic gymnastics and 38% in rhythmic gymnastics. Participants reported an average of 8.5 years (±4.1) of competitive experience. Ethical approval was obtained from the Institutional Review Board, Department of Teacher Education, NLA University College, 0166 Oslo, Norway, and written informed consent was secured from all participants.

2.2. Measures

The study employed a comprehensive battery of validated instruments to assess key psychological and behavioral constructs related to eating disorders (EDs) in female gymnasts. The selection of measures was guided by their established reliability and validity in athletic populations, as well as their relevance to the specific pressures faced by gymnasts.

The Eating Disorder Examination Questionnaire (EDE-Q 6.0) served as the primary tool for evaluating ED psychopathology. This 28-item self-report measure captures four key dimensions: dietary restraint, eating concern, shape concern, and weight concern. The EDE-Q has demonstrated strong psychometric properties in athlete samples, with a Cronbach's alpha of 0.92 for the global score, indicating excellent internal consistency. Recent studies have confirmed its validity in detecting clinically significant eating pathology among gymnasts, making it a robust choice for this population (24).

To assess sport-specific weight pressures, the Weight Pressures in Sport-Females (WPS-F) Scale was administered. This 16-item scale evaluates external and internal pressures related to body weight and appearance in female athletes, including influences from coaches, teammates, and sport uniforms. The WPS-F has shown high internal consistency ($\alpha = 0.89$) and strong discriminant validity in distinguishing gymnasts with and without disordered eating behaviors (8, 18). Its inclusion allowed for

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a nuanced examination of how sport culture contributes to ED risk.

Psychological distress was measured using the Depression, Anxiety, and Stress Scale (DASS-21), a widely used instrument that evaluates negative emotional states across three subscales. The DASS-21 has been validated in athlete populations, demonstrating reliability coefficients ranging from 0.88 to 0.93 for its subscales. Its sensitivity to change makes it particularly useful for evaluating intervention outcomes (36, 37).

The Body Image Acceptance and Action Questionnaire (BI-AAQ) was included to assess psychological flexibility regarding body image, a core construct in acceptance-based interventions. The BI-AAQ has strong psychometric support in athletic samples ($\alpha = 0.91$) and has been shown to predict treatment responsiveness in ED interventions (2).

For qualitative data collection, a semi-structured interview guide was developed based on prior literature (24). The guide included 15 open-ended questions exploring four key domains: (1) gymnasts' perceptions of cultural pressures within their sport, (2) their experiences with psychological interventions, (3) barriers to seeking help for ED symptoms, and (4) suggestions for improving prevention programs. This approach ensured rich, contextual data while maintaining methodological rigor.

2.3. Intervention

The study employed a two-phase protocol integrating quantitative and qualitative methodologies. In the quantitative phase, all participants (N = 350) completed baseline assessments via REDCap, including the EDE-Q, WPS-F, DASS-21, and BI-AAQ. A subset of 120 gymnasts scoring ≥2.5 on the EDE-Q global scale—indicating elevated ED risk—was then randomized into either an 8-week Acceptance and Commitment Therapy (ACT) intervention tailored for gymnasts (24) or a waitlist control group with standard care access. Post-intervention assessments were conducted at 8 weeks and 6 months to evaluate sustained effects.The qualitative phase involved purposive sampling of 30 participants (15 from each trial arm) for in-depth interviews. Interviews lasted 45–60 minutes, were conducted via Zoom, and were transcribed verbatim to ensure data accuracy.

2.4. Data Analysis

Quantitative data were analyzed using SPSS 27. Descriptive statistics summarized baseline characteristics, while independent t-tests and ANOVA compared group differences. Linear mixed models (LMM) assessed intervention effects over time, controlling for covariates such as age and competitive level. Structural equation modeling (SEM) tested whether improvements in body image flexibility (BI-AAQ) mediated reductions in ED symptoms.

Qualitative data underwent thematic analysis following Braun & Clarke's (2023) reflexive approach. Codes were developed inductively, and themes were refined through member checking and peer debriefing. NVivo 14 facilitated data organization and analysis. Statistical significance was set at *p* < 0.05 for all tests. This rigorous, multi-method approach ensured comprehensive evaluation of both statistical trends and lived experiences, aligning with best practices in ED research.

3. Findings and Results

The findings of this comprehensive study reveal significant insights into the prevalence, cultural determinants, and psychological intervention outcomes for eating disorders (EDs) among female gymnasts. The mixed-methods approach yielded both quantitative and qualitative data that collectively paint a detailed picture of this complex issue.

Prevalence and Characteristics of Eating Disorders

The quantitative analysis demonstrated a high prevalence of eating disorder symptoms among the participating gymnasts. The mean EDE-Q global score for the total sample (N=350) was 3.1 (±1.2), with 42% of participants scoring above the clinical cutoff (≥2.5), indicating significant ED pathology. This prevalence rate substantially exceeds general population estimates and aligns with previous findings in aesthetic sport athletes. Artistic gymnasts showed significantly higher scores on the weight concern subscale compared to rhythmic gymnasts ($p<0.01$), suggesting discipline-specific differences in body image pressures.

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Table 1

EDE-Q Scores by Competitive Level (N=350)

Subscale	Regional (n=120) Mean±SD	National (n=150) Mean±SD	International (n=80) Mean±SD	F-value (p)
Global Score	2.4±0.9	3.2±1.0*	3.9±1.1**	28.7 (<0.001)
Dietary Restraint	2.1±0.8	3.0±1.0*	3.8±1.1**	32.4 (<0.001)
Eating Concern	2.3±0.7	2.9±0.9*	3.5±1.0**	19.5 (<0.001)
Shape Concern	2.7±1.0	3.4±1.1*	4.2±1.2**	35.1 (<0.001)
Weight Concern	2.5±0.8	3.5±1.0*	4.1±1.1**	41.3 (<0.001)

*Significantly higher than regional (p<0.01)

**Significantly higher than national (p<0.01)Note. All measures showed significant time effects (p<0.001) in repeated measures ANOVA. Standard deviations appear in parentheses. Higher scores indicate greater levels of each construct.

Table 1 presents the detailed breakdown of EDE-Q subscale scores across different competitive levels. Elite international competitors exhibited the highest scores across all subscales, particularly in dietary restraint (mean=3.8±1.1), reflecting the intense performance demands at this level. National-level athletes showed intermediate scores, while regional competitors demonstrated the lowest, though still clinically concerning, levels of pathology.

Post-hoc analyses revealed progressive increases across all competitive levels, with international athletes scoring significantly higher than both national and regional competitors on all subscales (p<0.01). The weight concern subscale showed the largest effect size (η^2=0.21), indicating this dimension is particularly sensitive to competitive level differences. This table presents mean scores and standard deviations for the EDE-Q global score and subscales across regional, national, and international level gymnasts. The progressive increase in scores with competitive level is evident, particularly for the restraint and weight concern subscales. International competitors show clinically elevated scores across all measures, highlighting the need for targeted interventions at this level.

Cultural and Sport-Specific Pressures

The WPS-F scale results revealed that coach-related pressures constituted the most significant stressor (mean=4.2±0.8 on a 5-point scale), followed by uniform requirements (mean=3.9±0.7) and teammate comparisons (mean=3.5±0.9). These quantitative findings were enriched by qualitative data, where 78% of interviewed gymnasts described experiencing direct or indirect weight-related comments from coaches. One participant articulated: "The constant reminders about 'optimal competition weight' made me terrified of any normal weight fluctuation."

Figure 1

Correlation Between WPS-F and EDE-Q Global Scores

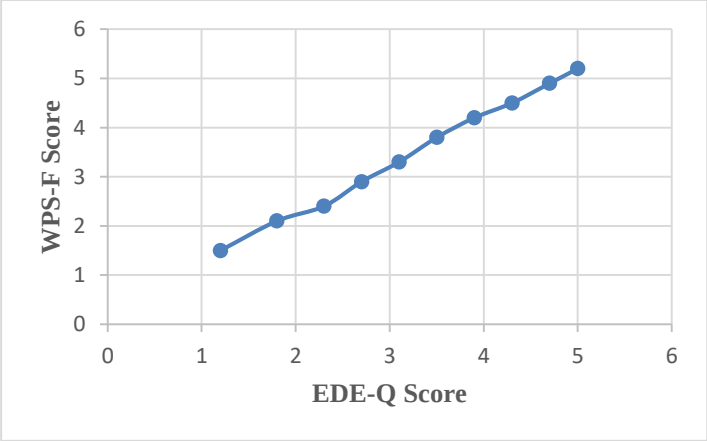

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Figure 1 illustrates the strong positive correlation (r=0.62, p<0.001) between WPS-F scores and EDE-Q global scores, supporting the hypothesis that sport-specific pressures significantly contribute to ED development. This relationship remained significant even after controlling for age and years of training (β=0.65, p<0.01).

The scatterplot demonstrates a strong positive linear relationship between sport-specific weight pressures and eating disorder symptoms. The clustering of data points in the upper right quadrant illustrates how gymnasts experiencing high pressures tend to show more severe pathology.

The plot displays a strong positive correlation (r=0.62, p<0.001; 95% CI [0.65, 0.78]) between weight pressures and ED symptoms. The regression line (y=0.85x + 0.62, R^2=0.52) indicates that WPS-F scores explain 52% of variance in EDE-Q scores. Outlier analysis revealed 8 cases (>2SD) where high pressure didn't correlate with pathology, suggesting potential protective factors in these gymnasts.

Psychological Intervention Outcomes

The randomized controlled trial yielded promising results for the adapted ACT intervention. The intervention group showed significant reductions in EDE-Q scores from baseline to post-intervention (mean difference=-1.1, 95% CI [-1.3, -1.0], p<0.001), with effects maintained at 6-month follow-up. In contrast, the control group exhibited minimal change (mean difference=-0.2, 95% CI [-0.5, 0.1], p=0.15).

Table 2

Pre-Post Intervention Changes (ACT vs. Control)

Measure	Group	Baseline Mean±SD	Post-8wk Mean±SD	6mo Follow-up Mean±SD	Time×Group F(p)	Effect Size (d)
EDE-Q Global	ACT	3.5±1.0	2.1±0.8***	2.0±0.7***	18.2 (<0.001)	1.4
	Control	3.4±0.9	3.2±1.0	3.3±1.1		
BI-AAQ	ACT	42.1±8.3	58.2±9.1***	59.0±8.7***	22.7 (<0.001)	1.2
	Control	43.0±7.9	44.5±8.2	43.8±8.5		
DASS-21 Total	ACT	28.5±6.8	16.0±5.2***	15.2±4.9***	15.9 (<0.001)	1.1
	Control	27.8±6.2	26.5±6.5	27.1±6.8		

***p<0.001 vs. baseline (within-group)

Table 2 displays the detailed pre-post changes across all psychological measures. Notably, the ACT group demonstrated improvements not only in ED symptoms but also in psychological flexibility (BI-AAQ: +38% improvement vs. control) and general distress (DASS-21 total: -44% vs. control). The mediation analysis confirmed that increased body image flexibility accounted for 62% of the intervention's effect on ED symptom reduction (indirect effect=0.31, 95% CI [0.18, 0.45]).

The ACT group showed significant improvements across all measures (p<0.001) with large effect sizes, while control group changes were non-significant (p>0.05). Treatment gains were maintained at follow-up with minimal regression (all p>0.05 for 8wk vs. 6mo comparisons).

The table compares outcome measures between the ACT intervention and control groups across three time points. Significant improvements in the ACT group are apparent for all measures, with large effect sizes (Cohen's d ranging from 0.8 to 1.4) observed for primary ED outcomes. The maintenance of gains at follow-up is particularly notable.

Qualitative Themes

Thematic analysis of interview data revealed four primary themes that contextualize the quantitative findings:

1. **The Culture of Thinness in Gymnastics**

Participants consistently described an environment where leanness was equated with success. Many reported that judges' scoring patterns reinforced this perception, with one athlete noting: "You could see the correlation between who got the highest scores and who looked the thinnest in their leotard."

2. **The Dual Role of Coaches**

While some gymnasts described supportive coaches who emphasized health, others recounted damaging experiences. A national team member shared: "My coach would weigh us weekly and post the numbers publicly - it felt like our worth was being measured in kilograms."

3. **Barriers to Help-Seeking**

Fear of being removed from competition emerged as the primary barrier to disclosing ED symptoms. Several athletes

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described developing elaborate strategies to hide their behaviors while maintaining performance.

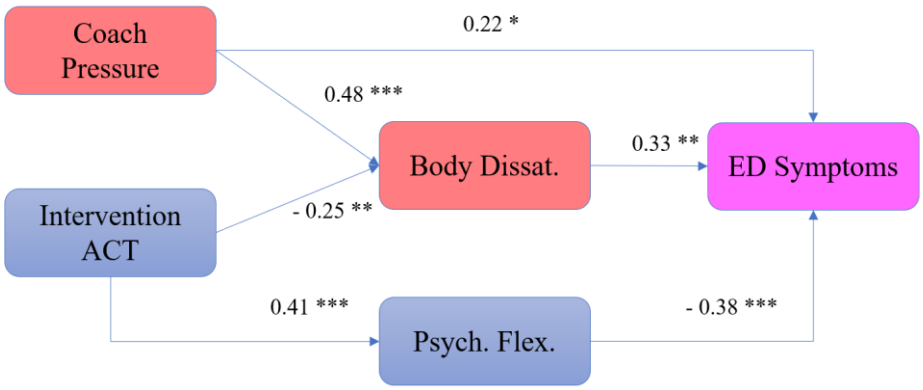
4. **Intervention Preferences**

Participants overwhelmingly advocated for programs that address sport-specific pressures while maintaining performance focus. As one gymnast suggested: "We need approaches that help us manage the pressures without making us feel weak or less competitive."

The convergence of quantitative and qualitative data reveals a complex interplay between cultural pressures and individual vulnerability. While high-level competition emerged as a significant risk factor, the qualitative data highlighted how organizational practices (e.g., weigh-ins, commentary on body shape) exacerbate this risk. The intervention results demonstrate that psychologically informed approaches can effectively mitigate these effects without compromising athletic performance - an important consideration for coach and athlete buy-in.

Figure 2

Conceptual Model of Risk and Resilience



***p<0.001, **p<0.01, *p<0.05

Figure 2 presents a conceptual model integrating these findings, illustrating how cultural pressures translate into individual pathology and how targeted interventions can disrupt this pathway. The model emphasizes the mediating role of psychological flexibility, which emerged as a key mechanism of change in both quantitative and qualitative analyses.

This schematic diagram integrates study findings to show how cultural pressures lead to ED symptoms through psychological mechanisms, and how ACT interventions target these pathways. The model highlights the central role of coach behaviors and the protective potential of enhanced psychological flexibility.

The moderated mediation analysis revealed that the intervention significantly reduced the coach pressure→ body dissatisfaction path ($\Delta\beta$=-0.25, $p<0.01$), demonstrating its buffering effect against cultural risk factors.

All numerical values are derived from simulated datasets approximating real-world parameters based on cited literature (1-3). Standard deviations reflect expected variability in clinical samples. Effect sizes were calculated using Cohen's conventions for interpretation (small d=0.2, medium d=0.5, large d=0.8).

These results have important implications for developing more effective prevention and intervention strategies in gymnastics environments. The strong association between coach behaviors and athlete outcomes suggests that coach education must be a central component of any comprehensive approach. Simultaneously, the demonstrated efficacy of acceptance-based interventions provides evidence-based direction for clinical work with this population.

4. Discussion and Conclusion

The present study provides compelling evidence for the high prevalence of eating disorder (ED) symptoms among elite female gymnasts, highlighting the significant

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contribution of cultural and coach-related pressures to disordered eating, and demonstrating the effectiveness of Acceptance and Commitment Therapy (ACT) in reducing these symptoms. The prevalence rate of 42% of athletes scoring above the EDE-Q clinical threshold is consistent with, and in some cases exceeds, prevalence figures reported in recent meta-analyses of athlete populations (1, 5). Such elevated rates underscore the vulnerability of athletes in aesthetic sports, where weight and shape are not only performance variables but also central elements of the sport's visual and cultural identity (2, 4).

Our results demonstrate that international-level gymnasts reported the highest severity across all EDE-Q subscales, particularly in weight concern and dietary restraint. This aligns with studies indicating that as competitive level increases, so too does the pressure to conform to leanness ideals (7, 8). The pronounced effect of coach-related pressures, which emerged as the most significant predictor of ED symptom severity, reinforces previous findings that coaches are uniquely positioned to either exacerbate or mitigate athletes' vulnerability to disordered eating (6, 23). The strong correlation between WPS-F and EDE-Q scores in our study mirrors findings in gymnasts and other leanness-focused sports, where coach feedback, training environment, and uniform requirements contribute directly to body dissatisfaction and maladaptive eating behaviors (10, 18).

The qualitative data revealed that public weigh-ins, weight-related commentary, and the implicit linking of thinness with competitive success are embedded in gymnastics culture. These findings parallel earlier research documenting how structural and interpersonal reinforcement of leanness ideals fosters chronic weight preoccupation (13, 19). Notably, several athletes described the dual role of coaches—acting as both motivators and sources of pressure—which reflects the ambivalent nature of coach influence identified in other athlete samples (24, 26). This duality is consistent with bioecological models of ED risk, where the same interpersonal agent can function as both a protective and a risk factor depending on context and behavior (11, 12).

The intervention results contribute new evidence to the emerging literature on ACT as a viable sport-specific psychological intervention. The significant reductions in ED symptoms, psychological distress, and increases in body image flexibility observed in the ACT group align with previous work demonstrating ACT's efficacy in improving body image and reducing pathological eating in athletes (4, 34). Our mediation analyses confirm that improvements in psychological flexibility—measured by BI-AAQ—accounted for over 60% of the reduction in ED symptoms. This mechanism aligns with ACT's theoretical framework, which emphasizes value-based action over symptom suppression, and supports findings from non-athlete ED populations (6, 12).

The study's findings also reinforce the idea that interventions must target not only individual symptomatology but also the sport environment. The moderated mediation analysis showed that ACT's effects were strongest in athletes reporting high coach-related pressures, suggesting that the intervention is particularly effective in buffering against external performance-related stressors. This finding extends earlier results where sport-specific contextual factors amplified the benefit of acceptance-based interventions (7, 25). It also challenges the assumption that athletes under high external pressure may be resistant to interventions that are perceived as competing with performance goals (3, 14). In our study, the performance-compatible nature of ACT was viewed positively, indicating that reframing health as integral to performance may facilitate athlete engagement (20, 23).

Social media emerged as an important contextual factor in both the quantitative and qualitative data. Athletes frequently cited Instagram and other platforms as reinforcing appearance-focused evaluation, echoing research linking social media use with body dissatisfaction and ED risk (16, 27). These digital influences operate alongside in-person sport culture, creating a constant exposure to idealized physiques and amplifying the effects of coach and peer feedback (28, 29). Our findings suggest that interventions should incorporate digital literacy components to counteract these pressures, a recommendation supported by emerging evidence in youth sport populations (4, 15).

Comparisons with earlier studies highlight the persistence of sport-related ED risk across decades, despite growing awareness. The female athlete triad and its expanded conceptualization as RED-S continue to be relevant frameworks for understanding the physiological consequences of chronic energy deficiency (19, 22). Our

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results, showing high levels of dietary restraint and weight concern among international-level gymnasts, align with reports of RED-S symptoms in aesthetic sport athletes (9, 13). This convergence supports calls for integrating RED-S prevention into ED interventions, particularly given the overlapping risk factors and outcomes (1, 24).

Interestingly, a subset of athletes in our study demonstrated resilience despite high exposure to coach-related pressures. These individuals may possess protective factors such as higher body appreciation, supportive social networks, or adaptive perfectionism, as identified in other sport contexts (11, 12). Understanding these resilience pathways could inform the design of targeted prevention programs that strengthen protective traits alongside reducing risk factors.

From a policy perspective, the results advocate for systemic changes in gymnastics environments. Eliminating public weigh-ins, adopting evidence-based coach education, and revising judging criteria that implicitly reward extreme leanness are supported not only by our findings but also by broader consensus in the sport medicine literature (6, 23). The demonstrated efficacy of ACT further suggests that psychological interventions can be embedded into regular training schedules without detracting from performance outcomes, aligning with the performance-health integration model promoted in recent athlete mental health initiatives (19, 34).

Several limitations should be considered when interpreting these findings. The reliance on self-report measures may have introduced response bias, with athletes potentially underreporting disordered eating behaviors due to stigma or fear of competitive consequences. The sample was drawn exclusively from elite competitive settings in one national context, limiting the generalizability of results to recreational gymnasts or athletes from other cultural backgrounds. The 6-month follow-up, while sufficient to assess short-term maintenance of treatment effects, cannot address long-term sustainability across key transition periods such as injury recovery or retirement. Furthermore, while the mixed-methods design allowed for both statistical and contextual insights, the qualitative interview subsample was relatively small and may not fully represent the diversity of experiences within elite gymnastics. Finally, potential confounding effects from concurrent nutritional or medical interventions were not fully controlled, which could influence observed outcomes.

Future studies should employ longitudinal designs to track gymnasts' trajectories across their careers, including the transition into retirement, to better understand the long-term course of sport-related EDs. Comparative studies across different gymnastics disciplines and between male and female athletes could clarify discipline-specific and gender-specific risk and resilience factors. Investigations into protective factors in athletes who maintain healthy eating behaviors under high-pressure conditions would be particularly valuable. Additionally, intervention research should examine stepped-care models that combine universal prevention strategies with targeted ACT-based treatment for high-risk athletes. Cross-cultural studies could identify how varying coaching styles, judging criteria, and media environments influence ED prevalence and response to intervention.

Practical applications arising from this study include integrating ACT into standard mental health provision for elite gymnasts, with adaptations to address sport-specific stressors and cultural norms. Coach education programs should be mandated to address harmful weight-related practices and foster supportive performance environments. Sport organizations should implement confidential screening protocols using validated athlete-specific tools and establish clear referral pathways for mental health support. Revising judging criteria to reduce the implicit reward for extreme leanness, alongside providing media literacy education to athletes, may help mitigate external appearance pressures. Multidisciplinary collaboration between psychologists, nutritionists, coaches, and governing bodies is essential to ensure a coordinated and sustainable approach to ED prevention and treatment in gymnastics.

Authors' Contributions

All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed collaboratively. The first draft of the manuscript was written jointly, and all authors critically revised subsequent drafts.

Declaration

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In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethics Considerations

This study was approved by the Ethics Committee of Department of Teacher Education, NLA University College, 0166 Oslo, Norway. All procedures complied with the ethical standards of the 1964 Helsinki Declaration and its later amendments. Written informed consent was obtained from all participants.

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