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Further Validation for a Measure of Disordered Eating in an Independent Sample of Male and Female Elite Athletes: The Athletic Disordered Eating (ADE) Scale

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ABSTRACT

Background: Elite athletes experience unique pressures and cognitions associated with disordered eating, which may not be appropriately captured by existing tools. The Athletic Disordered Eating (ADE) scale is a recently developed and first measure of disordered eating specifically developed and validated in current and former athletes. This study aimed to provide further validation for the ADE in an independent sample of elite athletes.

Method: Participants were 237 elite athletes ($M_{Age} = 26.1$, $SD_{Age} = 8.6$; 75.9% female; 73.0% current athletes) participating in various sports across Australia and the United States. Participants completed an online survey including the ADE, demographic questions, and other measures of eating disorder symptoms (Eating Disorder Examination—Questionnaire Short-form, Clinical Impairment Assessment), and related constructs. Twenty-five athletes also completed a clinical interview to determine eating disorder caseness.

Results: The four-factor structure of the ADE from the original validation was confirmed. Further, the ADE demonstrated adequate measurement invariance across male and female current and former athletes; internal consistency for the total score and each subscale; convergent and discriminant validity; and criterion-related validity—with a score of 40 balancing sensitivity and specificity against other scales with established cut-offs for a likely eating disorder. The high-risk cut-off (ADE $\geq$ 33) had high sensitivity but low specificity in identifying eating disorder cases, as confirmed by the clinical interview.

Discussion: The ADE is a low-time-burden screening tool for disordered eating, validated in independent samples of diverse athletes. It should be considered for future use in screening, early identification, and monitoring treatment progress in elite athletes.

Summary

- The Athletic Disordered Eating (ADE) scale was recently developed and validated to measure disordered eating symptoms, specifically in athlete populations.
- This scale is particularly relevant for elite athletes, who often experience unique pressures and cognitions associated with disordered eating.
- By providing validation of the ADE in an independent sample of elite athletes, this study supports its use as a screening tool for disordered eating in future research and practice.

1 | Background

Although recognized as both prevalent (Chapa et al. 2022; Karrer et al. 2020) and associated with potentially severe health and performance outcomes (Mountjoy et al. 2023; Pensgaard et al. 2023), the conceptualization and assessment of disordered eating and eating disorders among athletes is uncertain. Eating disorders constitute a group of mental disorders characterized by psychologically distressing and/or clinically impairing disturbances in one's behaviors, cognitions, and perceptions relating to their eating, exercise, and body image (American Psychiatric Association 2013). Elite athletes (i.e., competing at the national, international, professional, or National Collegiate Athletics Association (NCAA) D1 level; Karrer et al. 2020) often experience body and food pressures across these domains as part of their training and competition (de Bruin 2017), and there is a body of evidence indicating higher prevalence rates for eating disorders among elite athletes versus non-athlete controls (Fatt et al. 2024b). However, an additional proportion of elite athletes, while not meeting full diagnostic criteria for an eating disorder, experience a broad spectrum of disturbances in their eating, exercise, and body image (i.e., disordered eating; Rodin, Silberstein, and Striegel-Moore 1984), which are nonetheless associated with impairment and/or distress, compromised physiological and medical capacity, and poorer performance markers (Mountjoy et al. 2023; Wells et al. 2020). Screening tools that assess the full spectrum of disordered eating and are specific to this experience in elite athletes are essential for research and for facilitating early identification and intervention for at-risk athletes.

There are compelling reasons to conceptualize and assess a broader spectrum of disordered eating among elite athletes rather than focusing only on clinical eating disorders. For one, it is well accepted that the historical basis for the clinical diagnostic criteria for eating disorders (i.e., anorexia nervosa [AN] and bulimia nervosa [BN]) includes primarily clinical observations of young, white, cis-females reporting high levels of drive for thinness and dietary restriction (Gorrell and Murray 2019). However, elite athletes are gender and ethnically diverse and report disordered eating symptoms that align with diverse body ideals, including thin, muscular, and lean body-ideals (Darko 2009; de Bruin and Oudejans 2018), beliefs about leanness improving performance (Krentz and Warschburger 2013), and/or weight manipulation to meet sporting rules or regulations (e.g., meeting a weight class; Fatt et al. 2024a). Further, the seasonal nature within sports competition may lead to severe disordered eating only during certain times (Pinto et al. 2020), meaning that athletes may experience episodic disordered eating and thus may not meet the "chronicity" criteria for an eating disorder diagnosis (American Psychiatric Association 2013). Finally, elite athletes may report dieting, exercise, and body image-related behaviors within the context of high-level training and competition, which may be screened as "at-risk for an eating disorder" in the general population but may not be linked to pathology within their sporting context. For example, an elite athlete may respond to questions on eating disorder measures such as "I am aware of the calorie content of foods that I eat" (from the Eating Attitudes Test; EAT; Garner et al. 1982) due to the monitoring required in their training plan despite limited pathology. As such, the direct translation of existing assessment tools for eating disorders from the general population to elite athletes may overlook several aspects of the spectrum of disordered eating in this population.

Several measures have been developed to date in attempt to address some of these gaps, including the Athletic Milieu Direct Questionnaire (AMDQ; Nagel et al. 2000), Female Athlete Screening Tool (FAST; McNulty et al. 2001), Brief Eating Disorder in Athletes Questionnaire (BEDA-Q; Martinsen et al. 2014), and the Eating Disorders Screen for Athletes (EDSA; Hazzard et al. 2020), each with a focus on athlete populations (see Pope et al. 2015 for a review). However, Buckley et al. (2024) recently developed and validated the 17-item Athletic Disordered Eating (ADE) to address several limitations of these existing tools. For example, previous tools (e.g., AMDQ, BEDA-Q) typically have used a deductive approach to their item development using the eating disorder diagnostic criteria as a narrow framework (Pope et al. 2015). As outlined above, elite athletes' experiences with disordered eating may not align well with this framework. Contrastingly, items for the ADE were developed inductively through critical theory and qualitative findings of athlete experiences and evaluated for content validity by expert clinicians (e.g., sports dietitians), researchers (e.g., ED researchers), and current and former athletes, with consideration of the broader spectrum of disordered eating (Buckley 2021; Buckley et al. 2024). Further, the ADE is the first measure of disordered eating in athletes that has been validated quantitatively using both classical test theory analysis and the more modern approach of item response theory (i.e., Rasch modeling). Classical test theory is typically used to assess the reliability and validity of a scale's total score, and it assumes that each item equally represents the latent construct (Van Zile-Tamsen 2017). Conversely, item response theory assumes a varying relationship between each individual item and the latent construct, with benefits of increased reliability using fewer items and better assessment across a spectrum of severity (Van Zile-Tamsen 2017). Finally, few existing screeners for eating disorder symptoms have been validated in male athletes, and none have been validated in former athletes.

Buckley et al. (2024) first validated the ADE in a sample of current and former athletes across a variety of sports and competition levels, including gender-diverse athletes. The ADE demonstrated good content and face validity through

piloting with 68 current and former athletes. Structural validity was assessed through principal component analysis and exploratory factor analysis in a sample of 851 current and former male and female athletes, indicating a four-factor model, which Buckley et al. (2024) labeled as four subscales: *food and energy control* (five items), *bingeing* (three items), *body control* (four items), and *body discontent* (five items). Internal consistency, assessed through Cronbach's alpha, was adequate for the ADE's full scale ($\alpha = 0.91$) and for each subscale ($\alpha = 0.78–0.88$). Construct validity for the ADE was also good in the same sample, with moderate positive correlations with measures of eating disorder psychopathology (EAT-26; Brief Eating Disorder in Athletes Questionnaire) and moderate negative correlations with measures of intuitive eating (Intuitive Eating Scale-2) and body appreciation (Body Appreciation Scale-2). Buckley et al. (2024) also found good concurrent criterion-related validity of the total score against the clinical cut-off on the EAT-26 (Garner et al. 1982), creating four categories of disordered eating risk: minimal risk (total ADE < 25), moderate risk (ADE = 25–32; 99.3% sensitivity, 27.3% specificity), high risk (ADE = 33–44; 96.8% sensitivity, 49.7% specificity), and very high risk (ADE > 44; 79.9% sensitivity, 84.7% specificity). Finally, the ADE was also temporally stable in a sub-sample of 125 participants who re-completed the ADE 1–3 weeks later, with Intraclass Correlation Coefficients ranging from 0.92 to 0.96. As such, the ADE is a promising tool for future research and clinical use as the first measure for disordered eating (rather than eating disorders per se) that is grounded in athletes' experiences, has been validated using both classical test theory and Rasch modeling, and has been validated in a sample of athletes diverse in gender, sport type, and career stage.

There is a need for further psychometric research to provide evidence of the validity and reliability of the ADE. For instance, the initial validation sample included athletes at all levels, from amateur to elite (60.8%). Given that the sport-specific pressures outlined above are likely most pronounced in elite sporting environments (Fatt et al. 2024a), validation of the ADE in an elite athlete sample is warranted. Further, Buckley et al. (2024) assessed criterion-related validity against the EAT-26, but it has not yet been validated against other commonly used measures of eating disorder pathology.

Thus, the current study aimed to provide further validation for the ADE, using a sample of elite current and former athletes. We proposed the following hypotheses: the ADE and its four subscales will demonstrate adequate structural validity across the full sample of male and female, current and former elite athletes; the ADE will demonstrate adequate measurement invariance across male and female, current and former elite athletes; the ADE and its four subscales will demonstrate adequate internal consistency; the ADE will demonstrate adequate concurrent criterion-related validity against established cut-off scores on other measures of eating disorder symptoms; and the ADE will demonstrate adequate construct validity, with positive correlations with measures related to disordered eating and weaker correlations with measures less related to disordered eating. Further, we aimed to conduct exploratory analyses investigating sensitivity (i.e., ability to correctly identify true positives) and specificity (i.e., ability to correctly identify true negatives) for the ADE in predicting eating disorder caseness as determined by a gold standard diagnostic interview for eating disorders.

2 | Method

The study was approved by the Western Sydney University human ethics committee (H15085).

2.1 | Participants and Procedures

Participants were current and former elite athletes from the first wave of a longitudinal study of body image and disordered eating in elite athletes (the ASPIRE study). Recruitment procedures for the study have been reported elsewhere (Fatt et al. 2024c), but in brief, athletes were recruited through social media, snowball sampling, and advertising within elite sporting bodies within Australia and at an eastern NCAA D1 university in the United States. Consenting participants completed screening questions to determine their highest level of sports competition and age. Those who had competed or trained at the national, international, professional, or NCAA D1 level (i.e., elite level) and were 18 years and older ($N = 238$) were then able to complete the online survey, including demographic questions (e.g., gender), the ADE, and other measures of body image, eating disorder symptoms, and related constructs. A minimum of 10 participants per item is recommended when validating a scale (Morgado et al. 2017), suggesting a sample size of at least 170 participants for the present study. Athletes self-reported if they identified as a para athlete (i.e., competing athlete living with a disability; Jefferies, Gallagher, and Dunne 2012) and their primary sport of competition. These sports were then double coded by authors SF and NJ into sports categories (aesthetic, weight class, anti-gravitational, endurance, ball sports, power, technical, and other winter sports) according to Martinsen and Sundgot-Borgen (2013). One participant was excluded from analysis for failing at least two of the three attention checks, leaving 237 current and former elite athletes ($M_{Age} = 26.1$, $SD_{Age} = 8.6$; 75.9% female, 23.7% male, 0.4% other gender—see Table 1 for sample demographics).

At the end of the survey, participants could choose to be contacted for an additional interview. The 99 athletes who opted in were stratified into "minimal disordered eating risk" (ADE < 25) and "at least moderate disordered eating risk" (ADE ≥ 25), per Buckley et al. (2024). Thirty of the latter group were randomly allocated to another study (a qualitative interview-based study), with the 69 remaining athletes contacted to participate in a follow-up interview, which included the Eating Disorder Examination (EDE; Fairburn, Cooper, and O'Connor 1993)—a semi-structured clinical interview to determine eating disorder diagnosis. Twenty-five (36.2%) athletes responded to being contacted, consented, and completed the EDE, conducted virtually via Zoom by a postgraduate clinical psychology student who had received training on the EDE by author PH, who trained with the Oxford group and was trained in how to train others in administering the EDE. Interviewers were blinded to: (1) the aims of the study, and (2) participants' survey results (e.g., ADE scores). The audio

TABLE 1 | Descriptive statistics for the numeric and categorical variables.

Numeric variables	*M* (SD)
Age	26.1 (8.6)
BMI	24.7 (4.6)
Years since retirement (former athletes)	7.4 (8.6)
Disordered eating (ADE)	34.5 (12.7)
Male current athletes	27.8 (10.4)
Male former athletes	25.6 (16.4)
Female current athletes	35 (12.5)
Female former athletes	41.1 (11.1)
Eating disorder symptoms (EDE-QS)	9.3 (7.6)
Clinical impairment (CIA)	11.0 (10.5)
Body dissatisfaction (MI-BoD)	56.9 (25.6)
Compulsive exercise: avoidance of negative affect (CET-A-a)	15.8 (8.0)
Compulsive exercise: weight and shape concerns (CET-A-ws)	7.5 (4.9)
Psychological distress (K6)	12.8 (4.6)
Perceptions of stigmatization by others for seeking help (PSOSH)	8.1 (4.3)
Categorical variables	***N*** **(%)**
Sport type	
Endurance	59 (25.4)
Weight class	34 (14.7)
Aesthetic	15 (6.5)
Antigravitational	8 (3.5)
Technical	20 (8.6)
Power	17 (7.33)
Ball	61 (26.3)
Winter	4 (1.7)
Unclear	19 (6.0)
Country of birth	
Australia	183 (78.9)
Other	49 (21.1)
Self-identification as Aboriginal and/or Torres Strait Islander	3 (1.3)
Self-identification as a para athlete	15 (6.5)
Disordered eating risk (ADE)	
Minimal risk (0–24)	45 (19.7)
Moderate risk (25–32)	59 (25.9)
High risk (33–44)	68 (29.8)
Very high risk (45+)	56 (24.6)
EDE-QS above cut-off score (15+)	56 (24.8)
CIA above cut-off score (16+)	58 (26.5)

Abbreviations: ADE = Athletic Disordered Eating scale; BMI = body mass index; CET-A = Compulsive Exercise Test—Athlete; CIA = Clinical Impairment Assessment; EDE-QS = Eating Disorder Examination—Questionnaire Short-form; MI-BoD = Multifaceted Instrument for Body Image Disturbance; PSOSH = Perceptions of Stigmatization by Others for Seeking Help; SD = standard deviation.

recording of each interview was used for validation via blind-scoring by another interviewer (85.3% concordance). These scores and the recordings were then reviewed by authors SF, DM, and PH to determine eating disorder diagnosis against the DSM-5 criteria, including AN, BN, binge eating disorder (BED), other specified feeding and eating disorder (OSFED), and unspecified feeding and eating disorder (UFED) (see Supporting Information S1 for full details). SF, DM, and PH have research and clinical expertise in diagnosing eating disorders, and they were blinded to participants' survey scores during this process.

2.2 | Measures

See Table 2 for further details about each measure included.

2.2.1 | ADE

As outlined above, the ADE is a 17-item screening tool developed and validated to assess disordered eating, specifically in athletes (Buckley et al. 2024). Participants responded on a 5-point Likert scale (0 = *Never* to 4 = *Always*). Scores may be calculated using the full scale (summed for a possible range of 0–68) or for each of the four subscales: *food and energy control* (range: 0–20), *bingeing* (range: 0–12), *body control* (range: 0–16), and *body discontent* (range: 0–20). Based on comparisons with the clinical cut-off on the EAT-26 (Garner et al. 1982), respondents' total scores can be categorized into four levels of disordered eating risk: minimal risk (total ADE < 25), moderate risk (ADE = 25–32), high risk (ADE = 33–44), and very high risk (ADE > 44).

2.2.2 | Criterion-Related Validity

The Eating Disorder Examination—Questionnaire Short form (EDE-QS; Gideon et al. 2016) assesses eating disorder symptoms, and the Clinical Impairment Assessment (CIA; Bohn et al. 2008) assesses functional impairment associated with eating disorder symptoms. Both measures have established cut-off scores for a *likely eating disorder* in the general population (≥ 15 per Prnjak et al. 2020 and ≥ 16 per Bohn et al. 2008, respectively) and were used for criterion-related validity of the ADE.

TABLE 2 | Descriptions of the measurement tools used.

Measure	Construct assessed	Details	Possible range	Previous validation	McDonald's ω (current sample)
Athletic Disordered Eating (ADE) scale	Disordered eating	17 items, 5-point Likert scale	0–68	Athletes: mixed competition level (Buckley et al. 2024) Non-athletes: NA	0.91
Eating Disorder Examination—Questionnaire Short form (EDE-QS)	Eating disorder symptoms	12 items, 4-point Likert scale	0–36	Athletes: NA Non-athletes: eating disorder clinical sample (Gideon et al. 2016)	0.90
Clinical Impairment Assessment (CIA)	Functional impairment associated with eating disorder symptoms	16 items, 4-point Likert scale	0–48	Athletes: NA Non-athletes: eating disorder clinical sample (Bohn et al. 2008)	0.96
Multifaceted Instrument for Body Image Disturbance (MI-BoD)	Body dissatisfaction	20 items, 6-point Likert scale	20–120	Athletes: NA Non-athletes: undergraduate students, community adolescents, eating disorder clinical sample (Prnjak et al. 2024)	0.98
Compulsive Exercise Test—Athlete					
Weight and shape control subscale (CET-A-ws)	Compulsive exercise for weight and shape reasons	6 items, 6-point Likert scale	0–30	Athletes: mixed competition level (Plateau et al. 2014) Non-athletes: NA	0.93
Avoidance of negative affect (CET-A-a)	Compulsive exercise to avoid negative affect	4 items, 6-point Likert scale	0–20	Athletes: mixed competition level (Plateau et al. 2014) Non-athletes: NA	0.87
K6	Psychological distress	6 items, 5-point Likert scale	6–30	Athletes: NA Non-athletes: general population (Furukawa et al. 2003)	0.87
Perceptions of Stigmatization by Others for Seeking Help (PSOSH)	Perceived stigma from others for help-seeking	5 items, 5-point Likert scale	5–25	Athletes: NA Non-athletes: university students, clinical sample (Vogel, Wade, and Ascheman 2009)	0.91

Eating disorder caseness was determined against the DSM-5 diagnostic criteria for the 25 athletes who completed the EDE. Criterion-related validity for the ADE was assessed against eating disorder caseness, using participants' results from either the baseline survey or 6-month follow-up survey—whichever was closer in time to the 3-month period covered in the EDE. ADEs were completed between 0 and 68 days from the 3-month EDE period (Median = 2.0 days).

2.2.3 | Construct Validity (Convergent and Discriminant)

The Multifaceted Instrument for Body Image Disturbance (MI-BoD; Prnjak et al. 2024) assesses body dissatisfaction without bias toward any specific body ideal and the Compulsive Exercise Test—Athlete (CET-A; Plateau et al. 2014) assesses compulsive exercise across two domains that were most relevant for athletes: exercise for weight and shape control and for avoidance of negative emotion. These measures were expected to correlate strongly with the ADE. The K6 (Kessler et al. 2002) assesses psychological distress and was expected to correlate moderately with the ADE. The Perceptions of Stigmatization by Others for Seeking Help (PSOSH; Vogel, Wade, and Ascheman 2009) assesses stigma from others for seeking help and was expected to correlate weakly with the ADE.

2.3 | Analysis Plan

The analysis plan was preregistered on Open Science Framework (OSF) after the collection of the data, but before analyses of the data—https://doi.org/10.17605/OSF.IO/XUZNR. Little's MCAR test was performed to inspect the missing data pattern. Structural validity for the ADE and its four subscales was assessed through confirmatory factor analysis, with WLSMVS estimator for ordinal data. Goodness-of-fit indices criteria were as follows: Tucker–Lewis index (TLI) > 0.90; comparative fit index (CFI) > 0.90; Standardized Root Mean Square Residual (SRMR) < 0.08, Root Mean Square Error of Approximation (RMSEA) < 0.05 for excellent fit or 0.05–0.08 for adequate fit. Measurement invariance across male and female, current and former athletes, and lean and nonlean sport types was assessed using differential item functioning with the ordinal logistic regression approach (a flexible modeling strategy that can handle both binary and ordinal multicategorical item scores; Zumbo 1999), chi-square as a criterion, and a $p < 0.01$ as the threshold. Internal consistency for the ADE subscales was assessed using McDonald's omega. Convergent and divergent validity were assessed using Spearman correlation coefficients with scales measuring similar constructs (CET-A, MI-BoD, K6) and distinct constructs (PSOSH), respectively. Criterion-related validity for the ADE was assessed using the receiver operating characteristic (ROC) curve, sensitivity, and specificity against the cut-off scores on the EDE-QS and the CIA. Additional exploratory analyses were conducted in the 25 athletes who participated in the EDE clinical interview to investigate the sensitivity and specificity of ADE cut-offs for identifying eating disorder cases.

3 | Results

The proportion of missing data for each variable ranged from 2.1% to 13.9% ($M = 5.2\%$). Little's MCAR test showed that data were not missing completely at random ($\chi^2 = 881$; df = 551; $p < 0.001$), thus multiple imputation was performed using the mice package in R (version 3.16.0) and the predictive mean modeling. The imputed dataset was used for all subsequent analyses. Most participants were current female athletes ($n = 126$), followed by former female athletes ($n = 50$), current male athletes ($n = 47$), and former male athletes ($n = 8$). Univariate statistics for each variable are available in Table 1.

3.1 | ADE Validation

A four-factor model fit the data well ($\chi^2 = 195.339$; $p < 0.001$; CFI = 0.904; TLI = 0.957), although not all fit indices were "good" (robust RMSEA = 0.129 [95% CI = 0.115–0.144]; standard RMSEA = 0.082 [95% CI = 0.070–0.093]; SRMR = 0.075). All factor loadings were > 0.40 presented in Table 3.

Internal consistency was considered "good" for the *Bingeing* subscale ($\omega = 0.813$ [95% CI = 0.770–0.857]) and *Body Discontent* subscale ($\omega = 0.898$ [95% CI = 0.875–0.920]), and "acceptable" for subscales *Food and Energy Control* ($\omega = 0.745$ [95% CI = 0.692–0.799]) and *Body Control* ($\omega = 0.757$ [95% CI = 0.697–0.817]).

TABLE 3 | Factor loadings for each subscale of the ADE.

Subscale	Item	Factor loading
Food and energy control	ADE1	0.705
	ADE2	0.645
	ADE3	0.658
	ADE7	0.481
	ADE17	0.751
Bingeing	ADE4	0.669
	ADE15	0.983
	ADE16	0.754
Body control	ADE5	0.779
	ADE6	0.546
	ADE13	0.638
	ADE14	0.641
Body discontent	ADE8	0.865
	ADE9	0.823
	ADE10	0.815
	ADE11	0.861
	ADE12	0.845

Abbreviation: ADE = Athletic Disordered Eating scale.

Differential item functioning (DIF) was found in five items, yet these effects were largely negligible, with an exception being Item 9 ("My performance or mood is influenced by how I feel about my body"). No item had $\Delta\beta 1$ above the 0.1 criterion (10% change), which has previously been used as the criterion for the presence of uniform DIF (Crane, Belle, and Larson 2004). DIF could not be assessed for the *Bingeing* subscale due to a lower-than-required number of items ($n = 3$). For males, accounting for DIF would lead to slightly higher scores, suggesting scores obtained with the current scale—and therefore severity of disordered eating—may be underestimated for male athletes. Only one item (Item 6) was found to have DIF for athlete status (former vs. current athletes). Two items (Item 5 and Item 7) were flagged for DIF for lean versus nonlean sport type. However, these effects were all negligible ($\Delta\beta 1 < 0.1$).

As seen in Table 4, convergent and divergent validity was also supported, with the ADE subscales typically correlating most strongly with body image disturbance (MI-BoD; *r*: 0.476–0.821), followed by the CET-A *Weight and shape control* subscale (*r*: 0.423–0.672), psychological distress (K6; *r*: 0.237–0.536), and CET-A *Avoidance of negative emotion* subscale (*r*: 0.174–0.468). As expected, few of the ADE subscales were significantly associated with perceived stigma from others for seeking help (PSOSH), BMI, and age. The PSOSH scale was only significantly associated with the ADE Body Discontent subscale, with a small effect size. Further, BMI was only significantly associated with the ADE Bingeing subscale, with a small effect size.

Although the factor analysis indicated a four-factor model, we calculated sensitivity and specificity against the EDE-QS and CIA cut-off scores using the total ADE scores. The rationale for this was (1) replication of Buckley et al.'s (2024) approach to use the ADE total score in the initial validation, (2) theoretical and observed associations between the subscales (e.g., covariances between factors identified in the CFA ranged from 0.46 to 0.95, and ADE subscale correlations ranged from 0.34 to 0.67 in the present study), (3) good internal consistency for the total score (McDonald's $\omega = 0.91$), and (4) clinical utility of having a single cut-off score for clinical practice. As seen in Table 5, a score of ≥ 33 on the ADE (high risk range per Buckley et al. 2024) identified most of the athletes who scored above the clinical cut-offs for an eating disorder on the EDE-QS and the CIA, but had less than 60% specificity. A score of ≥ 45 on the ADE (very high risk range per Buckley et al. 2024) identified less than 70% of athletes scoring above the clinical cut-offs on the EDE-QS and the CIA but had almost 90% specificity. On investigating the ROC further, a score of ≥ 40 on the ADE was identified as a cut-off that best balanced sensitivity and specificity against the EDE-QS (see Figure 1) and CIA (see Figure 2) in our sample.

TABLE 4 | Convergent and divergent validity for the ADE: Spearman's correlations with each subscale.

	ADE subscale			
	Food and energy control	**Bingeing**	**Body control**	**Body discontent**
CET-A-a	0.468***	0.174**	0.334***	0.431***
CET-A-ws	0.672***	0.423***	0.608***	0.609***
MI-BoD	0.650***	0.476***	0.570***	0.821***
K6	0.385***	0.279***	0.237***	0.536***
PSOSH	0.110	0.078	−0.006	0.134*
BMI	0.067	0.215***	0.106	0.090
Age	0.055	−0.010	0.083	0.069

Abbreviations: ADE = Athletic Disordered Eating scale; BMI = body mass index; CET-A-a = Compulsive Exercise Test Athlete—Avoidance of negative affect; CET-A-ws = Compulsive Exercise Test Athlete—Weight and Shape control; MI-BoD = Multifaceted Instrument for Body Image Disturbance; PSOSH = Perceptions of Stigmatization by Others for Seeking Help.
*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

TABLE 5 | Sensitivity (specificity) of the ADE using receiver operator curves against the cut-off scores on the EDE-QS, CIA, and eating disorder caseness as assessed through clinical interview.

ADE cut-off	EDE-QS	CIA	EAT-26 (from Buckley et al. 2024)
≥ 25	1.000 (0.250)	0.955 (0.246)	0.993 (0.273)
≥ 33	0.932 (0.583)	0.821 (0.561)	0.968 (0.497)
≥ 40	0.828 (0.800)	0.687 (0.778)	—
≥ 45	0.655 (0.900)	0.537 (0.883)	0.799 (0.847)

Abbreviations: ADE = Athletic Disordered Eating scale; CIA = Clinical Impairment Assessment; EAT = Eating Attitudes Test; EDE-QS = Eating Disorder Examination—Questionnaire Short-form.

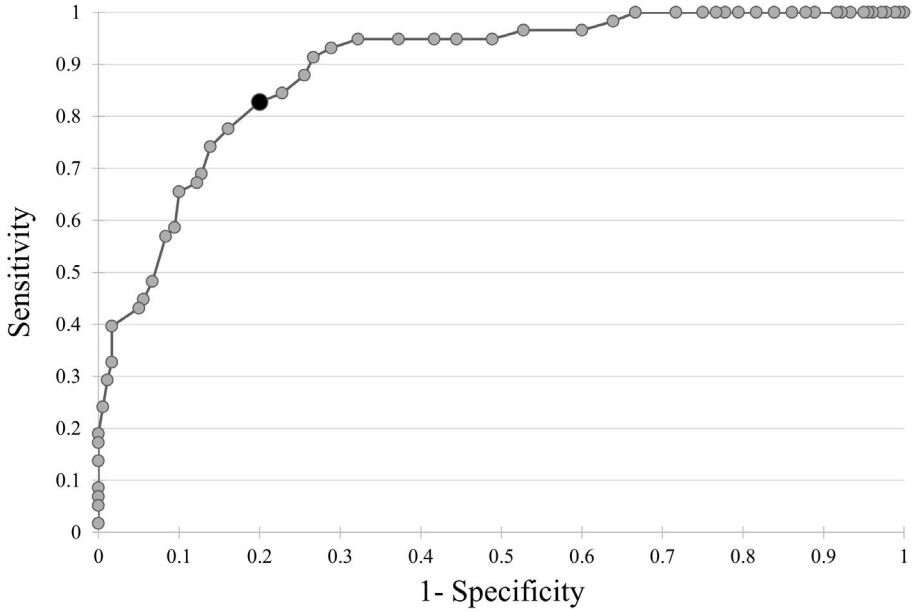

FIGURE 1 | ROC Curve: Eating Disorder Examination Questionnaire Short form. *Note:* Receiver-operating characteristic (ROC) curve against the Eating Disorder Examination—Questionnaire Short form. The black dot indicates ADE cut-off of 40.

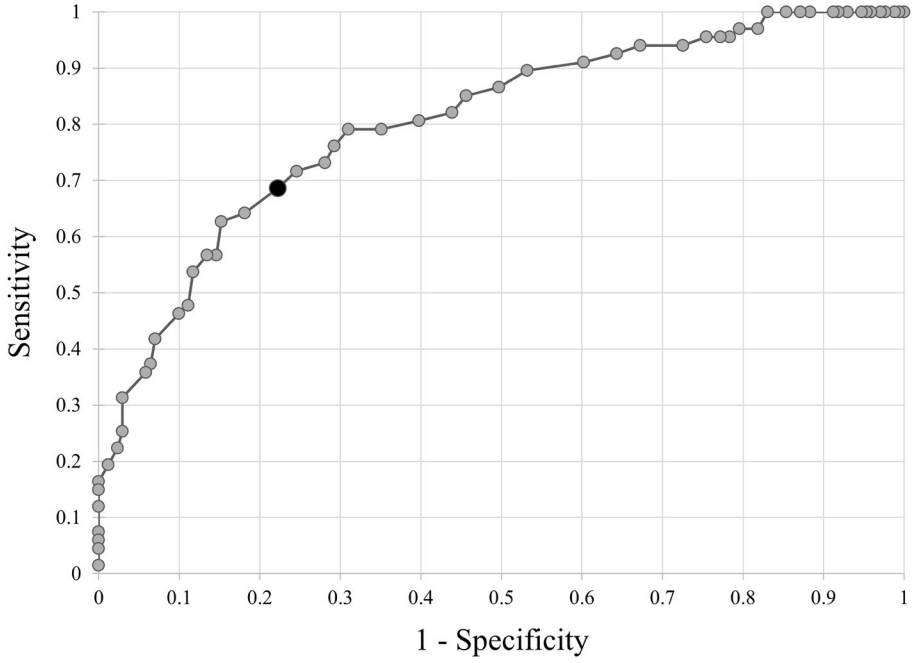

FIGURE 2 | ROC Curve: Clinical Impairment Assessment. *Note:* Receiver-operating characteristic (ROC) curve against the Clinical Impairment Assessment. The black dot indicates ADE cut-off of 40.

3.2 | Exploratory Analyses: Criterion-Related Validity for Eating Disorder Caseness

Of the 25 current and former elite athlete subsamples, who completed the EDE clinical interview, nine were determined to meet criteria for an eating disorder. All nine (100%) of these participants were correctly identified when using the high-risk ADE score of ≥33 ($n=15$) as a cut-off (i.e., true positives). However, an additional six (40%) participants with a high risk score on the ADE did not meet criteria for an eating disorder using the EDE interview (i.e., false positives). In contrast, using the very high risk ADE score of ≥40 ($n=9$) identified six (66.7%) true positives, three (33.3%) false positives, and three (18.8%) false negatives.

4 | Discussion

This study aimed to provide further validation of the ADE to assess disordered eating using a new sample of elite current and former athletes. As hypothesized and similar to the initial validation in athletes at various levels of competition (Buckley

et al. 2024), the ADE demonstrated adequate to excellent psychometric properties. This included structural validity for the four subscales, measurement invariance across male and female current and former athletes, internal consistency for the total score and each subscale, and convergent and discriminant validity. These findings support the use of the ADE as a valid screening tool for disordered eating in elite athletes.

The ADE was originally developed and validated to assess disordered eating as a broad construct in athletes rather than assessing only "eating disorders" within the narrow framework of existing diagnostic criteria, as evidenced by the bottom-up approach, which prioritized critical theory and lived experience (Buckley et al. 2024). Our validation of the ADE in an independent sample of male and female current and former elite athletes gives additional support for this conceptualization of disordered eating in elite athletes. The range of scores on the ADE reflects this "spectrum" of disordered eating (Wells et al. 2020) and supports Buckley et al.'s (2024) use of Rasch Analysis in the initial validation, which is better suited for assessing severity for a construct across subclinical and clinical levels (DeVellis and Thorpe 2021). This aligns with previous findings of high prevalence for both subclinical and clinical eating disorder symptoms in elite athletes (Fatt et al. 2024b).

A clear benefit of this conceptualization for disordered eating is its relevance for a broader range of athlete demographics. Screening tools for eating disorders have typically been developed and validated with a bias toward young, white, cis-female patients presenting with a drive for thinness (Gorrell and Murray 2019) and may not be relevant for elite athletes who are gender and ethnically diverse, with varying body ideals and motivations for disordered eating (Fatt et al. 2024a). The ADE addresses this bias by (1) avoiding the assessment of any specific "body ideal" (e.g., Item 8: "I am dissatisfied with my body shape or size") and (2) focusing primarily on the distress and impact associated with eating, exercise, and body image (e.g., Item 1: "I find spontaneous eating decisions challenging") rather than specific behaviors or weight/shape control—the latter of which can be elements of being an elite athlete. Similar to Buckley et al. (2024), our findings supported measurement invariance between current and former athletes, as well as athletes competing in lean versus nonlean sports. Contrary to Buckley et al. (2024), there was slight measurement invariance across gender, with inconsistent interpretations of Item 9 ("My performance or mood is influenced by how I feel about my body") and slight underestimations of DE for males using the total score. It is possible that females interpreted Item 9 to refer to body image, while males may have focused on bodily function. Overall, the ADE has now been validated in two independent samples (mixed competition level—(Buckley et al. 2024); elite level in the current study), each including male and female current and former athletes, competing across a wide variety of sports.

Although our findings provide support for the use of the ADE in assessing four constructs of disordered eating (i.e., the four subscales), there was also support for using the ADE's total score to screen for eating disorders in elite athletes. The suggested ADE cut-off scores for moderate risk and high risk from Buckley et al.'s (2024) initial validation against the EAT-26 demonstrated similar sensitivity and specificity against the cut-off scores on the EDE-QS and the CIA in the present study. However, Buckley et al.'s (2024) very high-risk ADE cut-off appeared more conservative in the current study, with lower sensitivity (54%–66%) and higher specificity (approximately 90%). Instead, an ADE cut-off score of ≥ 40 demonstrated a good balance of sensitivity (83%) and specificity (80%) against the cut-off scores on the EDE-QS. Further, in the subsample of athletes assessed for eating disorder caseness via EDE clinical interview, an ADE cut-off score of ≥ 33 (high risk) identified 100% of eating disorder cases, with 40% false positives. Comparatively, Lichtenstein et al. (2022) identified 90% of EDE-confirmed eating disorder diagnoses with 100% specificity using the EDE-Q as a screening tool in a sample of female elite athletes. This is consistent with the different approaches in conceptualization between the ADE (bottom-up approach assessing disordered eating broadly) and the EDE-Q (top-down approach based on the DSM-5 eating disorder diagnostic criteria) and may reflect a mismatch between eating disorder diagnosis and how disordered eating presents in elite athletes. Commensurate with a spectral view of disordered eating symptoms, we encourage users of the ADE, whether in practice or in future research, elect a cut-off score in line with their goals. For example, a cut-off score in the very high risk range (ADE ≥ 40) would be appropriate to identify athletes currently experiencing clinical eating disorder symptoms, but it may be too conservative to screen for early intervention or prevention of disordered eating more broadly. Contrastingly, using the high risk cut-off score (ADE ≥ 33) may be effective for flagging athletes who are experiencing more transient disordered eating symptoms or those who are at risk of developing an eating disorder in the future (e.g., those with cognitions but without specific behaviors), but not all of these athletes will meet full criteria for an eating disorder.

To date, research regarding prevalence and risk factors for disordered eating in elite athletes has been undermined by the use of assessment tools that have not been validated in athlete samples or, at times, in any sample (Fatt et al. 2024b). The use of scales that are theoretically grounded and have been validated in athletes (e.g., the ADE), coupled with other methodological considerations (e.g., representative sampling, matched-control groups), provides a solid foundation for improving future research. Practically, the ADE can be used by clinicians and sports organizations for identification of at-risk athletes. Given the ADE's relatively low time burden (i.e., 17 items) and its focus on the full spectrum of disordered eating (which often proceeds or precedes clinical eating disorders), it may be used for broad screening across entire athlete populations to identify athletes at moderate, high, and very high risk, creating opportunities for early intervention (Torstveit et al. 2023). Such an approach should, however, have clear policies regarding the confidential use of said data, given that athletes may be motivated to under-report symptoms for fear of negative consequences (e.g., being overlooked for team selection, forced to miss training sessions). Interpretations of athletes' results should consider both the subscale scores and the total score. The ADE may also be used as an indicator of treatment outcome for both clinicians and researchers, with Buckley et al. (2024) finding that a change in score of seven points or more is indicative of clinical relevance.

4.1 | Limitations

Several limitations to the current study should also be considered. First, the ADE has received limited validation in several specific demographics, including nonbinary and gender diverse athletes, para athletes, and those living outside of Australia. Validation across various athlete populations should be a priority for future research. Further, the ADE's use in nonathlete samples is currently unclear. Although it was not designed to be a universal tool, it may be useful, with appropriate adaptations and validation, in other areas of high competitiveness (e.g., performing arts). Additionally, due to the longitudinal design of the broader ASPIRE study, the timing between when the athletes completed the ADE and the time covered as part of the clinical interview (EDE) was not consistent and could be quite long (up to 68 days). It is possible that the athlete's symptoms may have changed during this window; however, the median number of days for this gap was not large (2 days). Future research should look to confirm these exploratory findings, including validation against diagnosed eating disorder cases in a larger sample.

5 | Conclusion

The ADE provides the first tool developed for assessing disordered eating in athletes, with validation in an independent sample of male and female current and former elite athletes. These findings reinforce a necessary shift toward viewing disordered eating as a spectrum of risk rather than merely the presence or absence of a clinical eating disorder. We advocate for the ADE's use in future research (assessing prevalence, risk factors, and interventions for disordered eating) and in clinical practice (for screening, early intervention, and assessing treatment progress). Further validation is needed across people with diverse demographic features.

Author Contributions

Scott J. Fatt: conceptualization, data curation, formal analysis, funding acquisition, project administration, writing – original draft. **Katarina Prnjak:** formal analysis, writing – review and editing. **Georgina L. Buckley:** resources, writing – review and editing. **Emma George:** conceptualization, funding acquisition, supervision, writing – review and editing. **Phillipa Hay:** conceptualization, funding acquisition, supervision, writing – review and editing. **Nikki Jeacocke:** supervision, writing – review and editing. **Deborah Mitchison:** conceptualization, funding acquisition, supervision, writing – review and editing.

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Conflicts of Interest

Phillipa Hay has consulted for Takeda Pharmaceuticals and is a consultant to Tryptamine Therapeutics. Nikki Jeacocke is employed by the Australian Institute of Sport. Scott J. Fatt is in receipt of a Research Training Program scholarship and an Australian Eating Disorders Research and Training Centre scholarship. Georgina L. Buckley was the first author on the initial development and validation of the Athletic Disordered Eating (ADE) scale. In the present study, Georgina L. Buckley was only involved in providing the ADE measure and reviewing the manuscript draft; Georgina L. Buckley had no involvement in the data curation, data analysis, or initial interpretation of the findings.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.