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Prevalence of disordered eating, eating disorders and risk of low energy availability in professional, competitive and recreational female athletes based in the United Kingdom

Francis Robert Jose Sharps[a], Laura Jane Wilson [a], Catherine Anna-Marie Graham[b] and Christopher Curtis [a]

[a]London Sports Institute, Middlesex University, London, UK; [b]Oxford Brookes Centre for Nutrition and Health, Faculty of Health and Life Sciences, Department of Sport, Health and Social Work, Oxford Brookes University, Oxford, UK

ABSTRACT

Eating disorders (ED), disordered eating (DE) and low energy availability (LEA) can be detrimental to health and performance. Previous studies have independently investigated the prevalence of ED, DE or LEA; however, few combined methods have identified risk within female athletes. The aim of this study was to identify the prevalence of ED, DE and LEA in UK-based female athletes and investigate whether associations exist between age, competition level and primary sport. The Female Athlete Screening Tool (FAST) and Low Energy Availability in Females Questionnaire (LEAF-Q) were used in a cross-sectional study design. A total of 112 responses eligible for analysis were received. A total of 16%, 44% and 53% of female athletes were at risk of ED (FAST: >94), DE and LEA, respectively. Competition level (recreational, competitive or professional athletes; fishers, $p \leq 0.05$) influenced and was a predictor of FAST ($R^2 = 0.076$, $F_{(1,110)} = 10.067$, $p \leq 0.05$, variance inflation value; VIF = 1.0) whereas age influenced (age: $H_{(2)} = 13.128$, $p \leq 0.05$), and was a predictor ($R^2 = 0.144$, $F_{(2,109)} = 9.170$, $p \leq 0.05$, VIF = 1.0) of LEAF-Q. A positive correlation was observed between FAST and LEAF-Q scores ($R = 0.496$, $p \leq 0.05$). Age and competition level may be predicting risk factors of ED/DE and LEA within female athletes; however, further research is required to support the findings of this present study.

KEYWORDS

Eating disorders; female athletes; nutrition; sport; RED-S

Introduction

Eating disorders (ED), disordered eating (DE) and low energy availability (LEA) can impact physiological and psychological function (Melin et al., 2014). ED are categorised as a group of psychological conditions characterised by an obsession with body mass/shape and behaviours with food that may lead to purging, starvation, fasting and excessive exercise (Bratland-Sanda & Sundgot-Borgen, 2013). Individuals with DE display similar behaviours but do not necessarily meet the full criteria to be diagnosed with an ED (Vo, Accurso, Goldschmidt, & Le Grange, 2017). Both ED and DE can have negative effects on exercise and sporting performance with an increased risk of overuse injuries, bone fractures and cardiac complications (El Ghoch, Soave, Calugi, & Dalle Grave, 2013). Energy availability is defined as the amount of energy remaining for physiological processes and bodily functions after energy required for exercise is subtracted (Logue et al., 2018; Mountjoy et al., 2014). LEA occurs when energy expenditure exceeds energy intake, with insufficient energy available for normal physiological functioning (Mountjoy et al., 2014; Slater, Brown, McLay-Cooke, & Black, 2017). LEA has previously been categorised at <30 kcal (125 kJ)/kg fat-free mass (FFM) per day (Logue et al., 2018 ; Mountjoy et al., 2018), although it should be noted this is an estimation for such a threshold and may be influenced by a number of factors. Moreover, LEA with or without ED or DE can occur due to intentional attempts to modify body composition, intentional (or unintentional) increased energy expenditure via excessive exercise, and/or reduced energy intake, resulting in a failure to match energy intake with energy expenditure (De Souza et al., 2014; Gibbs, Williams, & De Souza, 2013; Melin et al., 2014; Sundgot-Borgen, 1994).

Female athletes are considered a high-risk population for ED, DE or LEA, with research suggesting between 6% and 45% of female athletes have an ED, in comparison to 5–9% of females within the general population (Bratland-Sanda & Sundgot-Borgen, 2013). Prevalence of ED, DE and LEA varies among female athletes, with athletes competing in weight dependent and aesthetic sports often showing higher prevalence (Sundgot-Borgen, 1993); however, ED, DE and LEA have also been observed in female team sport athletes (Condo, Lohman, Kelly, & Carr, 2019; Prather et al., 2016;

CONTACT Christopher Curtis c.curtis@mdx.ac.uk London Sports Institute, Middlesex University, Hendon, London, NW4 1RL, UK

Sundgot-Borgen & Torstveit, 2007). Several studies (Knapp, Aerni, & Anderson, 2014; Martinsen, Bratland-Sanda, Eriksson, & Sundgot-Borgen, 2010; Nichols, Rauh, Barrack, Barkai, & Pernick, 2007; Nichols, Rauh, Lawson, Ji, & Barkai, 2006; Rosendahl, Bormann, Aschenbrenner, Aschenbrenner, & Strauss, 2009; Schtscherbyna, Soares, de Oliveira, & Ribeiro, 2009; Toro et al., 2005) have implemented ED/DE-related questionnaires developed and validated for general populations; however, such tools may be considered unsuitable for identifying ED/DE within female athlete cohorts (Knapp et al., 2014). The use of validated screening tools to evaluate female athletes such as the Female Athlete Screening Tool (FAST) and Low Energy Availability in Females Questionnaire (LEAF-Q) is recommended (Logue et al., 2018; Melin et al., 2014). FAST differentiates between healthy athletes and respondents with ED or DE (Knapp et al., 2014; McNulty, Adams, Anderson, & Affenito, 2001). Whereas LEAF-Q is designed to detect athletes at risk of symptoms associated with LEA and has shown high sensitivity (78%) and specificity (90%) in detection (Melin et al., 2014). The combination of LEAF-Q and FAST has been utilised previously by Folscher, Grant, Fletcher, and van Rensberg (2015) to investigate prevalence of ED and risk of female athlete triad within ultra-marathon runners; however, this approach has not been previously used in differing sport disciplines.

Identification of ED, DE and LEA is important within female athlete populations to allow practitioners and clinicians to support athletes at risk of either performance decrements (Kong & Harris, 2015; Logue et al., 2019) or health-related consequences of female athlete triad, or relative energy deficiency (RED-S) (De Souza et al., 2014; Mountjoy et al., 2014). With this in mind, the aims of the present study were to (a) identify the prevalence of ED, DE and LEA within professional, competitive and recreational female athletes based in the United Kingdom (UK) by using both FAST and LEAF-Q, (b) determine whether FAST and LEAF-Q scores differ based on age category or competition level (COMP), and (c) determine the relationship between FAST and LEAF-Q.

Methods

Participants

A cross-sectional descriptive study design (via anonymous, online questionnaire) was utilised to ascertain the prevalence of ED, DE and risk of LEA in female athletes aged between 18 and 40 years who participate in sport at a recreational ($n = 68$), competitive ($n = 35$), or professional ($n = 9$) level. Post-hoc power analyses were undertaken, with *ES* calculated from LEAF-Q means of each group (team, individual; *ES*: 0.64) with $\alpha = 0.05$ (two-tailed), which determined beta at 0.91. Professional athletes were defined as any athlete undertaking ≥10 h of training per week whose athletic performance has achieved the highest level of competition (e.g. Olympics, international/national representation) and receiving a full-time wage for sport undertaken (McKinney, Velghe, Fee, Isserow, & Drezner, 2019). Competitive athletes were defined as any athlete undertaking ≥6 h of training per week with a view to participate in official competitions (e.g. university athletes) and whose full-time job is not that of a full-time athlete (McKinney et al., 2019). Recreational athletes were defined as those undertaking ≥4 h of training per week who do not receive any money for partaking in sport and participate for enjoyment (McKinney et al., 2019). Age categories of 18–24 years, 25–30 years and 31–40 years were utilised due to the expectation that female athletes within this age range would be eumenorrheic (Pokoradi, Iversen, & Hannaford, 2011). Primary sport undertaken was reported and then categorised based on VO_{2MAX} intensity as per the methods of Logue et al . (2019) and Mitchell, Haskell, Snell, and Van Camp (2005). The study received institutional ethical approval and all participants provided informed consent prior to completing the survey.

Online questionnaire

Both FAST and LEAF-Q questionnaires were uploaded manually to an online survey platform (Qualtrics; Provo, Utah, USA, 2019), the survey links were distributed via social media and email advertisement. The questionnaire required data on participant age, sport and level of competition (COMP). Participants were asked to manually list the primary sport they participated in, which was then categorised and used for analysis.

Female Athlete Screening Tool (FAST)

FAST is a validated screening tool to identify eating pathology in female athletes, consisting of 33 questions. Participants were required to select a response from four possible answers (4 points (pts) = Frequently, 3pts = Sometimes, 2pts = Rarely, 1 point = Never) with a reverse scoring system used for questions 15, 28 and 32. Responses were totalled to give an overall score indicating the risk of DE/ED. A score of 74–94 indicates a risk of subclinical DE whilst a score of >94 indicates a risk of clinical ED (McNulty et al., 2001).

Table 1. Descriptive statistics from all eligible questionnaire responses.

	Age (years)			COMP		
	18–24	25–30	31–40	$COMP_{Rec}$	$COMP_{Comp}$	$COMP_{Pro}$
Responses (n =)	50	31	31	69	34	9
Category (%)	45	28	28	62	30	8

Low Energy Availability in Females Questionnaire (LEAF-Q)

The LEAF-Q is a validated screening tool that consists of 25 questions on injury history, gastrointestinal function, menstrual function and oral contraceptive use. Injury and gastrointestinal discomfort were assessed by ordinal scales and an open category to specify the types of injury/illness, etc. Menstrual function and oral contraceptive use were assessed by dichotomous and ordinal scales. Participants were considered at risk of LEA if a score of ≥8 was attained.

Statistical analysis

All data were analysed via SPSS (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp). Normality was assessed via the Shapiro–Wilks test. A one-way ANOVA or Kruskal–Wallis was used to identify differences in FAST and LEAF-Q means between questionnaire scores and age category, COMP, and VO_{2max}, respectively. Post-hoc testing was conducted where appropriate. Chi-squared or Fisher's exact tests were used to determine if the percentage of those above/below FAST and LEAF-Q cutoffs differed based on age, comp level, and VO_{2MAX} categories. Bonferroni corrections were applied where appropriate. Following this, a stepwise regression analysis was carried out to determine the contribution of age category and COMP to final questionnaire scores (both FAST and LEAF-Q). A variance inflation value (VIF) of less than 5 was considered acceptable (Ruengvirayudh & Brooks, 2016). Finally, a Spearman's rank correlation was conducted to determine the relationship between FAST and LEAF-Q. An alpha level of $p \leq 0.05$ denoted significance.

Results

Participant characteristics

Participant age and COMP demographics can be seen in Table 1. A total of 129 responses were received. Of these, 17 incomplete questionnaires were excluded from analysis (total responses eligible for analysis; $n = 112$). Sports represented within the survey were soccer $n =$ 12; 19%, rugby union $n = 44$; 70%, hockey $n = 3$; 5%, netball $n = 2$; 3%, cricket and Gaelic football both $n = 1$; 2%, running $n = 18$; 37%, powerlifting $n = 14$; 29%, cycling $n = 4$; 8%, Olympic weightlifting $n = 3$; 6%, boxing, acrobatics, kickboxing, MMA, competitive yoga, swimming, tennis, golf, athletics and climbing all $n = 1$; 2%.

FAST questionnaire scores

Results from FAST can be seen in Table 2. A total of $n =$ 49 athletes (44%) were at risk of DE and $n = 18$ athletes (16%) were at risk of ED. FAST scores differed based on COMP (COMP: $F_{(2,109)} = 3.081$, $p \leq 0.05$). Tukey's *post-hoc* tests showed significantly lower scores in $COMP_{Rec}$ compared to $COMP_{Comp}$ ($p \leq 0.05$), whereas FAST scores did not differ based on age or VO_{2MAX} (both $p > 0.05$). There was no difference in FAST score category between age (Fishers, $p \geq 0.05$), whereas FAST category differed based on comp level (Fishers, $p \leq 0.05$). *Post-hoc* testing highlighted fewer recreational athletes were at risk of clinical ED FAST category (29.4%), when compared to the risk of subclinical ED (64%) and no risk of ED (71%; $p \leq 0.05$). More competitive athletes were at risk of clinical ED FAST category (65%), when compared to the risk of subclinical ED (26%) and no risk of ED (22%; $p \leq 0.05$). Stepwise multiple regression demonstrated COMP modestly predicted FAST scores ($R^2_{adj} = 0.076$, $F_{(1,110)} = 10.067$, $p \leq 0.05$, VIF = 1.0; Table 3).

LEAF-Q questionnaire scores

Results from LEAF-Q can be seen in Table 2. A total of $n = 59$ athletes (53%) were considered at risk of LEA.

Table 2. Results of FAST and LEAF-Q with response scores n = and percentages (%) of participants at risk of ED, DE and LEA and chi-square cross tabulation analysing age and COMP against FAST and LEAF-Q scores.

		FAST			LEAF-Q	
	Questionnaire scoring	<74	74–94	>94	<8	>8
	Total scores n = (%)	45 (40%)	49 44%)	18 (16%)	53 (47%)	59 (53%)
Age (years)	18–24	17 (34%)	28 (56%)	5 (10%)	19 (38%)	31 (62%)
	25–30	12 (39%)	9 (29%)	10 (32%)	12 (39%)	19 (61%)
	31–40	16 (52%)	12 (39%)	3 (9%)	22 (71%)	9 (29%)
COMP	Recreational	32 (46%)	31 (45%)	6 (9%)	38 (55%)	31 (45%)
	Competitive	10 (30%)	13 (38%)	11 (32%)	12 (35%)	22 (65%)
	Professional	3 (33%)	5 (56%)	1 (11%)	3 (33%)	6 (67%)

Table 3. Results from regression analysis of independent predictors on dependent variables, FAST and LEAF-Q.

Predictor – FAST	*B*	SE (*B*)	*β*	R^2
COMP	4.780	2.198	.203*	0.041
Predictor – LEAF-Q				
Age (years)	−1.744	.550	−.290*	0.084

*Indicates statistical differences at $p \leq 0.05$ level.

LEAF-Q scores differed based upon age (age: $H_{(2)} = 13.128$, $p \leq 0.05$). Mean LEAF-Q score differed between VO_{2MAX} groups ($p \leq 0.05$). *Post-hoc* pairwise comparisons indicated those who were categorised as high VO_{2MAX} had lower LEAF-Q score vs. medium VO_{2MAX} ($p \leq 0.05$). LEAF-Q category differed based on age (Fishers, $p \leq 0.05$). *Post-hoc* testing indicated fewer 31–40-year-olds were in LEA risk group (14.5%) vs. LEA no-risk group (41.5%; $p \leq 0.05$). LEAF-Q category also differed based on VO_{2MAX} (Fishers, $p \leq 0.05$). *Post-hoc* testing revealed a lower percentage in the high VO_{2MAX} group had LEA risk (27%) vs. LEA no risk (55%). A higher percentage in the medium VO_{2MAX} group had a risk of LEA (53%) vs. LEA no risk (26%). COMP did not influence LEAF-Q (COMP: $H_{(2)} = 2.196$, $p \geq 0.05$). Stepwise multiple regression demonstrated age modestly predicted LEAF-Q scores ($R^2_{adj} = 0.144$, $F_{(2,109)} = 9.170$, $p \leq 0.05$, and VIF = 1.0; Table 3).

FAST and LEAF-Q questionnaires

A positive moderate correlation between FAST and LEAF-Q scores was observed ($R = 0.496$, $p \leq 0.05$) indicating a relationship between DE/ED and LEA.

Discussion

The primary aim of this study was to determine the prevalence of ED, DE and LEA within professional, competitive and recreational female athletes in the UK across a range of ages and sports. A combined approach of using FAST and LEAF-Q was implemented to ascertain eating pathology and areas related to LEA. The primary findings were (1) FAST indicates 16% and 44% of female athletes were at risk of ED and DE, respectively, (2) LEAF-Q indicates 53% of female athletes were considered at risk of LEA, and (3) a moderate positive correlation between FAST & LEAF-Q scores indicates a relationship between DE/ED and LEA.

To the authors' knowledge, only one previous study by Folscher et al. (2015) has implemented both LEAF-Q and FAST concurrently to ascertain the prevalence of ED/DE and LEA within female athletes. Folscher et al. (2015) found 5%, 27% and 44% of participants at risk of ED, DE, and LEA, respectively. The present study demonstrates a higher prevalence of ED, DE and LEA, despite having a smaller sample ($n = 112$ vs Folscher et al., 2015; $n = 306$). These differences could be explained due to Folscher et al. (2015) utilising a participant group comprised solely of endurance runners. Folscher et al. (2015) reported participants were made up of $COMP_{Rec}$ and $COMP_{Pro}$; however, unlike the present study, no sub-group analyses were conducted to identify differences in FAST and LEAF-Q with COMP. Previous self-report studies have described higher rates of both LEA (Ruengvirayudh & Brooks, 2016) and DE in control groups compared to athletic cohorts (Hoch et al., 2009; Rosendahl et al., 2009). However, Martinsen and Sundgot-Borgen (2013) investigated prevalence using both self-report measures and clinical interviews in female and male adolescent elite athletes and non-athletic controls. After self-report measures, non-athletes had a higher prevalence of ED (Athlete: 25%, control: 51%, $p \leq 0.001$) yet, after clinical interview adolescent athletes were seen to have a higher prevalence (athlete: 7%, control: 2%, $p \leq 0.001$). This suggests that self-report measures alone are potentially inaccurate as adolescent athletes may under-report their symptoms. Within the present study, participants aged 25–30 years demonstrated the highest rates of ED and LEA (32% and 61%, respectively) with participants between 18 and 24 years showing highest prevalence of risk of DE (56%).

Our findings suggest $COMP_{Pro}$ athletes have higher rates of LEA risk (67%) and DE (44%) while $COMP_{Comp}$ athletes were found to have higher rates of ED risk (32%), these findings are further supported by our multiple regression analyses, which indicate that FAST scores increase with COMP. The small number of professional athletes in the present study makes it difficult to generalise the findings; however, studies by Sundgot-Borgen (1993) and Sundgot-Borgen and Torstveit (2007) found lower rates of DE in female athletes at 18% and 20%, respectively. Additionally, Logue et al. (2019) observed a higher risk of LEA among females who participated competitively in sport compared with those who were recreationally active (77% vs. 23%, $p = 0.01$), with an LEA risk of 1.7–1.8 times more likely among participants who reported competing in sport at international (45%) or provincial/inter-county level (47%), compared to those who were recreationally active (Logue et al., 2019). These results present a much lower rate of risk than reported in the present study ($COMP_{Pro}$: 67%, $COMP_{Comp}$: 65%, and $COMP_{Rec}$: 45%). However, the present results are comparable with Slater et al. (Slater et al., 2017) who reported 45% of $COMP_{Rec}$ to be at risk of LEA according to LEAF-Q. Despite this, both Logue et al. (2019) and the current

study discovered higher level athletes ($COMP_{Comp}$ and $COMP_{Pro}$) to have an increased risk of LEA than $COMP_{Rec}$ athletes. Logue et al. (2019) proposed higher level athletes are more prone to LEA due to generally higher training intensity and duration than $COMP_{Rec}$. These findings suggest higher rates of LEA (and possible consequent DE) are likely due to energy demands in $COMP_{Comp}$ and $COMP_{Pro}$ not being met. While all COMP levels may be at risk of DE and LEA, the reasoning behind such risks is not fully clear. For instance, $COMP_{Rec}$ is unlikely to have nutritional support when compared to $COMP_{Comp}$ and $COMP_{Pro}$; therefore, $COMP_{Rec}$ may be at greater risk of unintentional DE and LEA (Slater et al., 2017). Conversely, training and demands of competitive sport are higher in $COMP_{Comp}$ and $COMP_{Pro}$, meaning a higher energy demand is required – if these are not met, $COMP_{Comp}$ and $COMP_{Pro}$ may also be at risk of DE and LEA (Logue et al., 2019).

Although not analysed independently in the current investigation, endurance athletes are often suggested to be at the greatest risk of LEA (Folscher et al., 2015 ; Pollock et al., 2010). This could be associated with excessive energy expenditure as highlighted by Logue et al. (2019) who found that participants had an increased risk (odds ratio of 1.06) of suffering from LEA for each additional hour of exercise per week. Our findings indicate that COMP is a modest predictor of FAST (accounting for a proportion of 3%), whereas age is the modest predictor of LEAF-Q (accounting for a proportion of 14%). These novel observations add to work conducted by Abbott et al. (2020) who, despite adopting differing validated questionnaires; clinical perfectionism questionnaire (CPQ-12) and eating attitudes test (EAT-26), observed athletic status (player vs. control) and perfectionism were significant predictors of DE, accounting for 21% of variation (p = 0.001) in female athletes. These findings indicate that COMP/athlete status may be a risk factor of ED/DE for female athletes. Our multiple regression findings indicate that despite COMP being a predictor of FAST, this accounted for ~3%; therefore, additional variables may be influencing factors and warrant further investigation. Information gathered from athlete screening could be utilised to monitor the progression of ED/DE and implement preventative strategies such as nutritional education/interventions before ED, DE or LEA occurs (Harrington, Jimerson, Haxton, & Jimerson, 2015; Joy, Kussman, & Nattiv, 2016).

The present study is not without limitations. The study aimed to recruit female athletes from a range of differing COMP levels however, only 8% of respondents were $COMP_{Pro.}$ Therefore, despite contributing to the findings, these data should be interpreted with caution in professional/elite female athlete cohorts. Additionally, because all participants were from the UK, findings may not be representative of female athletes from differing countries and cultures. It is also important to highlight that this study only assessed the risk of ED, DE and LEA via an anonymous, self-report questionnaire. Although FAST and LEAF-Q have been widely used and provide clinical sensitivity, they can only detect individuals who may be at risk of developing ED, DE, or LEA and would require a clinical follow-up. Subsequently, follow-up investigations into the prevalence of ED, DE or LEA may wish to consider implementing clinical interviews, biochemical and/or exercise testing to further support findings from survey data. Thus, findings from this study are limited to prevalence estimations of the general risk of ED, DE and LEA within these populations. Finally, the aims of this study were to observe the prevalence of DE, ED and LEA within female athletes within the UK, as a result, no control group was implemented for comparison against this cohort. Future research may wish to utilise this to make comparisons between female athletes of varying demographics and the corresponding sedentary female cohorts.

Conclusion

Overall, 16% of female athletes were at risk of ED, 44% were likely to have DE and 53% had LEA. Nevertheless, the risk of DE, ED and LEA was evident in all subgroups and highlights the need for regular screening in order to aid early interventions to prevent potential decrements in performance and health. Additionally, nutrition education strategies may need to be considered to inform female athletes and (where appropriate) interdisciplinary practitioners of potential negative effects of ED, DE and LEA on performance and health. This statement may be particularly pertinent in situations where female athletes may be aiming to manipulate energy intake to elicit training adaptation (e.g. modify body composition and increase in training load). Future research could further investigate potential ED/DE issues using a combined approach of the methods adopted within the present study, clinical interviews and detailed athlete screening to clarify these findings.

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No potential conflict of interest was reported by the author(s).

ORCID

Laura Jane Wilson http://orcid.org/0000-0002-3744-6132
Christopher Curtis http://orcid.org/0000-0002-4386-0284

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