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“It’s hard to find balance when you’re broken”:

Exploring female endurance athletes’ psychological experience of recovery
from relative energy deficiency in sport (RED-S)

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Abstract

Introduction: This study aimed to explore qualitatively the psychological experience of recovery from relative energy deficiency in sport (RED-S). More specifically, it sought to understand: how RED-S is experienced from a psychological perspective; sources of psychological conflict in the ongoing management of energy availability (EA); and athlete responses to psychological conflict in the pursuit of optimal EA.

Methods: Eight female endurance athletes identifying as “in recovery” or “recovered” from RED-S (M age = 29.78 years) participated in this integrated methods multiple case-study. Participants engaged in an initial topical life history interview, before completing an online diary over a 21-day period, taking photographs of psychological triggers for seven days, and participating in a follow-up interview. Data were analysed using reflexive thematic analysis.

Results: The domain summary, *in too deep and treading water*, captured the significant psychological implications of RED-S. Seven sources of psychological conflict reported while managing EA were identified. The domain summary *a constant tug of war* represented the responses to these sources of psychological conflict in the ongoing management of EA. Within this domain summary, the themes *in two minds* and *an emotional rollercoaster* illustrated the cognitive and affective responses to psychological conflict, while *giving in* and *the only way is through* represented the adaptive and maladaptive behavioural responses during recovery, respectively.

Conclusion: This study offers novel insights into the complex nature of recovery from RED-S and highlights the importance of considering psychological factors underpinning improved physiological functioning and overall wellbeing during RED-S recovery.

Keywords: low energy availability; disordered eating; eating disorder; mental health; overtraining

1.0 Introduction

Protecting psychological wellbeing is paramount when considering the long-term health of an athlete (Reardon et al., 2019). Engagement in regular physical activity (PA) is widely regarded as beneficial for psychological wellbeing, with research highlighting its potential role in the prevention and management of some mental health conditions, including depression and anxiety (e.g., Rebar et al., 2015). Despite this evidence, individuals engaging in high levels of PA without adequate nutritional intake are susceptible to developing numerous conditions that have negative implications for both physical functioning and psychological health (e.g., Hughes & Leavey, 2012). More specifically, when energy intake (EI) is insufficient to meet the daily energy requirements of the body after accounting for exercise energy expenditure (EEE), this results in a state of low energy availability (LEA; Loucks, 2004), which has been estimated to affect up to 58% of athletes across a variety of sports and physical pursuits (see Logue et al., 2020 for a narrative review).

Low energy availability has been identified as the aetiological factor underpinning relative energy deficiency in sport (RED-S), a complex syndrome of impaired health and performance in exercising populations (Mountjoy et al., 2014). The physiological manifestations of RED-S, which are considered to be direct consequences of LEA, include compromised health (e.g., menstrual function, bone health, immunity) and performance decline (e.g., decreased training response and coordination; Mountjoy et al., 2014). Despite RED-S being primarily regarded as a physiological condition, psychological health has been proposed to share a reciprocal relationship with LEA within the RED-S model, whereby psychological concerns can precede *or* result from LEA (Mountjoy et al., 2014; 2018). Despite this proposition, the psychology of RED-S has received limited attention in the extant literature and its interactions with physiological health remain largely unexplored (Schofield et al., 2020).

1 Recently, several studies have contributed important insights into potential
2 psychological factors influencing the onset or maintenance of LEA in athletic populations.
3 Thorpe and Clark (2020) reported that athletes face a complex range of psycho-socio-
4 physiological pressures (e.g., the lean sporting body ideal), which may prompt intentional
5 reductions in EI and/or increased EEE to influence body composition (Montani et al., 2015).
6 Moreover, some individuals may also exhibit pre-existing disordered eating (DE) behaviours
7 or a clinically diagnosed eating disorder (ED), which might perpetuate a cycle of under-
8 fuelling and/or overtraining (Loucks, 2020). It is important to note, however, that RED-S can
9 occur both in the presence and absence of such psychopathology (Mountjoy et al., 2014). For
10 example, additional sport-specific factors (e.g., high energy demands, injuries) also constitute
11 metabolic stressors that can generate and increase psychological stress in athletes (Turner et
12 al., 2019). As such, it has been proposed that psychological stress may indirectly contribute
13 to LEA through behaviours such as restrictive eating and excessive exercise, which may be
14 adopted as a means of coping with such stress (e.g., Berga, 2019).

15 In terms of its consequences, LEA has been previously associated with various
16 presentations of compromised psychological health, including: eating and exercise
17 psychopathology (e.g., Torstveit et al., 2019); anxiety (e.g., Tranoulis et al., 2020); and
18 depression (e.g., Ackerman et al., 2019). However, the continued reliance on cross-sectional
19 methods makes it difficult to determine whether psychological factors are a consequence of
20 the physiological state of LEA/RED-S, or resultant from pre-existing eating psychopathology
21 (Schofield et al., 2020). Furthermore, there are also some limitations with the measures used
22 to classify LEA. For example, Ackerman et al. (2019) found a positive association between
23 LEA and self-reported depression symptoms, however, LEA was classified on the basis of a
24 positive response to an ED self-report measure. In turn, this approach might overlook
25 inadvertent or intentional causes that may occur in the absence of DE/ED.

1 The importance of moving beyond classifying LEA based on DE/ED symptoms is
2 highlighted by recent qualitative work in endurance athletes, which found that regardless of
3 of how LEA is initiated, some of its short-term implications (e.g., weight loss or performance
4 improvements) can promote or perpetuate a cycle of under-fueling and/or overtraining among
5 athletes, resulting in physiological symptoms associated with RED-S (Langbein et al., 2021).
6 For an athlete to restore optimal physiological functioning following the presentations of
7 such symptoms (e.g., resumption of menses), it is necessary to increase EI and/or reduce EEE
8 to achieve adequate energy availability (EA; Mountjoy et al., 2014; Thein-Nissenbaum &
9 Hammer, 2017). However, while an athlete may be deemed ‘recovered’ physiologically from
10 RED-S, based upon biometric indices (e.g., resumption of menses, weight restoration), failing
11 to address underlying psychological health concerns could result in recurrent setbacks and a
12 subsequent return to restrictive EI or excessive EEE (Mountjoy et al., 2014). Indeed, research
13 indicates that practices promoted by current treatment recommendations, such as periodic
14 monitoring of body weight and specific objective targets for weight restoration (e.g.,
15 Mountjoy et al., 2015), may be sources of significant psychological distress for an athlete
16 with DE/ED, and can even trigger ED onset in some athletes (Arthur-Cameselle et al., 2017).
17 Furthermore, in a qualitative exploration of female athlete ED recovery experiences,
18 maladaptive cognitions (e.g., punishing self-talk and internalising rigid rules about fuelling
19 and exercise) often prompted negative emotions (e.g., low self-concept, psychological
20 distress), which ultimately hindered recovery progress, as the athletes described relapsing
21 into past unhealthy ED behaviours in an attempt to alleviate their emotional discomfort
22 (Arthur-Cameselle & Quatromoni, 2014).

23 Despite this evidence regarding the impact of maladaptive cognitions and emotions
24 upon eating and exercise behaviours, recent qualitative studies have suggested that athletes
25 who have recovered, or are recovering, from RED-S can be aware of the detrimental health

1 implications of the condition, yet still possessing a desire to achieve or maintain a lean
2 physique or low body mass, which can undermine their efforts to achieve optimal EA
3 (Langbein et al., 2021; Thorpe & Clark, 2020). In a mixed-methods study of elite female
4 cyclists, Schofield et al. (2021) reported that some athletes with sub-optimal EA and LEA
5 may acknowledge the importance of adequate EA for physiological adaptations and
6 performance improvements (e.g., improved muscle mass and strength), but simultaneously
7 need to contend with internal and external pressures to avoid increasing fat mass or overall
8 body mass. Similarly, Stoyel et al. (2021) recently highlighted how elite male and female
9 endurance athletes who internalise the conflicting beliefs and expectations of society (i.e.,
10 food is to be enjoyed and embraced as central to social connection) and the sporting domain
11 (i.e., an athlete's eating behaviours should reflect their dedication to their sport) may engage
12 in DE behaviour to strike a balance between these competing demands. Overall, this evidence
13 emphasises the importance of identifying and understanding the harmful beliefs that could
14 initiate psychological conflict, and ultimately perpetuate a cycle of LEA that results in
15 symptoms associated with RED-S.

16 One psychological theory that may explain such conflict during recovery is cognitive
17 dissonance theory (Festinger, 1957), which postulates that an individual experiences
18 psychological discomfort when engaging in behaviours that are inconsistent with their
19 beliefs, values, or attitudes. In turn, the individual is motivated to achieve psychological
20 consistency by realigning their contradictory thoughts and behaviours (Stice et al., 2019).
21 Dissonance-based prevention programmes have been successfully implemented with athletes
22 in ED recovery, whereby tasks and exercises designed to create dissonance prompt an
23 individual to reject their initial harmful attitudes (e.g., pursuit of the thin body ideal; Stice et
24 al., 2012). However, in the broader field of RED-S, research has yet to capture longitudinal
25 insights into how such conflict is experienced and navigated in the pursuit of RED-S

1 recovery. Given the potentially detrimental consequences of RED-S, further research is
2 needed to understand how RED-S ‘recovery’ is experienced from a psychological
3 perspective. Furthermore, although quantitative studies have generated important insights
4 into relationships between LEA and psychological indices, they offer limited understanding
5 into *how* and *why* psychological factors may influence the onset, or indeed, amelioration of
6 LEA. Therefore, greater understanding regarding the underlying aetiology of LEA, including
7 unfavourable attitudes, emotions, and behaviours that could perpetuate it, is required to
8 enable sports personnel to support individuals to recover from RED-S, both physically and
9 psychologically.

10 The aim of the study was to explore qualitatively the psychological experience of
11 recovery from RED-S in endurance athletes. More specifically, we sought to address three
12 research questions (RQ): (RQ1) how is RED-S recovery experienced from a psychological
13 perspective?; (RQ2) what sources of psychological conflict are encountered in the ongoing
14 management of EA?; and (RQ3) how do athletes experience and respond to psychological
15 conflict associated with the RED-S recovery journey? By sampling endurance athletes, a
16 population at heightened risk of experiencing LEA (Loucks, 2007), and examining their
17 psychological experience of RED-S recovery, the current study sought to contribute novel
18 insights into psychological factors underpinning efforts to recover from RED-S in endurance
19 athletes. In turn, this information could inform the development of recommendations that
20 support coaches and the wider athletic entourage in facilitating both optimal performance and
21 the maintenance of long-term health.

22 2. Methods

23 2.1 Research Approach

24 The current study was approached from the philosophical position of critical realism
25 (Danermark et al., 2019), which combines ontological realism (reality exists independent of

1 our knowledge of it) and epistemological constructivism (our knowledge of that reality is
2 partial, incomplete, and fallible). Case study research can provide insights into social
3 phenomena within a real-world context, with the in-depth study of multiple cases facilitating
4 exploration of similarities and differences within and between individuals (Yin, 2014).
5 Qualitative methods are well-suited to understanding *how* and *why* certain outcomes occur
6 (Maxwell, 2012) and the intergration of multiple methods, a key tenet of case study research
7 (Yin, 2014), can yield different insights into complex phenomena that might be more difficult
8 to generate using a single method alone (Chamberlain et al., 2011). Therefore, an integrated
9 methods multiple-case study approach was employed to generate detailed insights into how
10 RED-S recovery was experienced and navigated in athletes.

11 **2.2 Participants**

12 To provide a detailed understanding of the psychological recovery journey from RED-
13 S, we sought to purposefully sample information-rich cases (Patton, 2015). Participants were
14 required to: be 18-40 years of age; self-identifying as ‘in recovery’ or ‘recovered’ from RED-
15 S associated with engagement in sport and/or exercise; and participating in an endurance
16 sport¹ for at least 150 minutes per week during the period of self-identified RED-S, thus
17 ensuring that participants were meeting the recommended guidelines for physical activity
18 (Bull et al., 2020) for at least some period of their self-identified RED-S experiences.
19 Following approval from the ethics committee at the authors’ institution, a recruitment poster
20 containing key study information and a description of LEA/RED-S² was circulated via
21 multiple social media channels and invited eligible individuals to contact the first author, who
22 then forwarded an information sheet via email. Eight female endurance athletes (*M* age =

¹Endurance sport’ included any sport characterised by “whole-body, dynamic exercise that involves continuous efforts and lasts for 75 seconds or longer” (McCormick et al., 2015, p. 998)

²The recruitment poster stated: “Low energy availability occurs when an individual’s energy intake is insufficient to support the daily functioning of the body once exercise activities have been considered. LEA has been identified as the underlying cause of a number of detrimental health and performance consequences in Relative Energy Deficiency in Sport (RED-S)”.

1 29.75 years, $SD = 5.03$) matching the eligibility criteria were recruited (Table 1). At the time
2 of their RED-S experience, three of the athletes were competing at international level in their
3 respective sports, but the majority were competing at sub-elite levels according to criteria
4 proposed by Swann et al. (2015). Of the eight athletes sampled, one-quarter (Distance
5 Runners 1 and 4) identified as fully ‘recovered’ from the consequences of RED-S, both
6 psychologically (e.g., no longer reporting depression, anxiety, or persistent DE cognitions)
7 and physically (e.g., resumption of eumennorrhoea, healing of bony stress injuries,
8 overcoming chronic illness), while the remaining six participants considered themselves ‘in
9 recovery’ physically and psychologically (Table 1). Five participants retrospectively self-
10 diagnosed themselves as having experienced RED-S in the past based on the health and
11 performance impairments resulting from LEA (i.e., rather than receiving a formal medical
12 diagnosis at the time). The other three athletes reported a formal medical diagnosis of RED-S
13 within the three years prior to the study, several years after the introduction of RED-S
14 terminology (Mountjoy et al., 2014). Participants will hereafter be referred to according to
15 their primary sport and an assigned number. Participants provided informed consent to
16 participate in the study as a whole, prior to their initial interview, and consent was revisited
17 and gained prior to each subsequent research activity. All participants completed each of the
18 four research activities and were thus given a £10 voucher as an inconvenience allowance
19 following completion of the study.

20 [INSERT TABLE 1 ABOUT HERE]

21 **2.3 Data Collection**

22 To explore the RED-S recovery journey, data were collected for each participant via
23 multiple qualitative methods over a 6-week period on average. The data collection period
24 comprised four, sequentially-ordered phases: a topical life history interview; an online diary;

1 a photovoice task; and a follow-up interview. Data collection and analysis were led by the
2 first author.

3 **2.3.1 Initial Interview**

4 A topical life history interview seeks to explore a single instance or series of
5 instances, phase(s), or themes within the history of an individual's life (Allen-Collinson,
6 2011). Life history approaches have been previously employed in the sport and exercise
7 psychology literature to explore experiences of DE (e.g., Papathomas & Lavallee, 2014), ED
8 (e.g., Papathomas & Lavallee, 2006), disability and injury (e.g., Gaskin et al., 2010; Smith &
9 Sparkes, 2005), and mental illness (e.g., Carless, 2008). Each participant engaged in a face-
10 to-face topical life history interview with the first author. A semi-structured interview
11 approach was adopted to generate an in-depth account of each participant's experience
12 (Smith & Sparkes, 2016). Building on past research (e.g., Langbein et al., 2021), the
13 interview guide (Supplementary File 1) featured questions that sought to explore key life
14 events influencing the participants' RED-S experience and recovery journey to illuminate
15 personal meanings of RED-S recovery, and how RED-S was experienced from a
16 psychological perspective (RQ1). To identify key events during their recovery journey and
17 explore the psychological experiences accompanying them, timelining was employed,
18 whereby participants co-constructed a visual timeline of events in a collaborative effort with
19 the first author (Adriansen, 2012). This enabled participants to describe their thoughts,
20 feelings, and subsequent behaviours at the time of each key event occurring when asked (e.g.,
21 "can you remember how you were feeling at the time?"). The timelines were then revisited
22 in the follow-up interview (see 2.3.4 *Stimulated-Recall Interview*) to allow participants to
23 provide additional insights into life events significant to their experiences. Interviews lasted
24 on average 78 minutes (range = 60-124 minutes), took place in neutral locations that were
25 convenient to the participants, and were transcribed verbatim by the first author.

1 **2.3.2 Online Diary Task**

2 Diary methods enable participants to report and record their experiences (Cao &
3 Henderson, 2021) and can provide information about individuals' cognitions, affect, and
4 coping behaviours in response to psychological distress (e.g., Lee-Flynn et al., 2011). An
5 online diary method was employed to identify sources of psychological conflict participants
6 encountered when managing their EA (RQ2) and to capture their responses to such conflict
7 (RQ3). After their topical life history interview, participants were provided with a hyperlink
8 to a Qualtrics survey and asked to record responses over a 21-day period. Participants were
9 asked to record triggers of psychological conflict as and when they arose, along with any
10 thoughts, feelings, and behaviours that accompanied or succeeded them. This reporting
11 method is a form of event-contingent recording, whereby information is recorded each time
12 an event matching a pre-determined definition occurs (Reis et al., 2014). Based on language
13 used to describe psychological conflict experienced in RED-S 'recovery' in previous research
14 (Langbein et al., 2021), a trigger of psychological conflict was defined as "anything which
15 causes you to experience conflicting thoughts or a discrepancy between your thoughts and
16 subsequent behaviours towards managing your energy availability". The first author sent a
17 weekly email prompt to encourage at least one weekly diary entry but reiterated that
18 participants were under no obligation to do so and could withdraw at any time.

19 **2.3.3 Photovoice Task**

20 Photovoice is a participatory action research strategy that enables individuals to
21 reflect on visual images and the meanings ascribed to them (Sutton-Brown, 2014). After
22 completing their 21-day online diary task, participants were asked to photograph any objects,
23 situations, or circumstances that caused them to experience psychological conflict (as per the
24 previous definition) while managing their EA. Photovoice has been previously applied within
25 sport settings, including in research exploring environmental influences on eating behaviour

1 among team sport athletes (Caswell & Hanning, 2018) and perceptions and experiences of
2 the impact of sport on health promotion (Leipert et al., 2011). More recently, photovoice has
3 been used to explore factors hindering and facilitating recovery efforts from EDs (Saunders
4 & Eaton, 2018). In the current study, photovoice was employed to provide additional insights
5 into sources of psychological conflict that were encountered during efforts to manage EA
6 (RQ2), and the thoughts, feelings, and subsequent behaviours that the sources elicited, both at
7 the time they were captured, and on reflection in their follow-up interview (RQ3; see below).
8 To enable further exploration of the photographs in the follow-up interview, participants were
9 instructed to store photographs on a personal portable device (e.g., mobile phone).

10 ***2.3.4 Stimulated-Recall Interview***

11 A semi-structured follow-up interview was arranged with each participant after the
12 diary and photovoice data collection periods (M duration = 13.88 days later, range = 1-29
13 days). The diary entries and photographs were used to stimulate recall and gain further
14 insights into sources of, and responses to, psychological conflict associated with RED-S
15 recovery. The interviews were conducted in person ($n = 5$) or online ($n = 3$), and a consistent
16 approach to establishing rapport (i.e., outline study aim and interview format) was employed
17 before the interviews to minimise differences across interview methods (DiCicco-Bloom &
18 Crabtree, 2006). The interviews began with a reflection on the period since the first interview
19 and a broad exploration of how participants felt about managing their EA during this time
20 (e.g., “how have things gone since we last met, with regard to managing your EA?”). The
21 athletes were then given time to review their topical life history timeline as a form of member
22 reflection (Smith & McGannon, 2018), which enabled them to offer further insight into their
23 recovery journey or make any necessary changes (i.e., “I am going to give you a few minutes
24 to refamiliarise yourself with this timeline and make any comments, additions or changes that
25 you wish, which you may feel are relevant or important to your experience”). All participants

1 confirmed the accuracy of the visual summaries, making only minor modifications to
2 language or event dates (e.g., correcting spelling of sport-specific terminology). Some
3 member reflections also generated new insights into key experiences that were identified in
4 the initial interview. For instance, when revisiting her key events timeline in her follow-up
5 interview, Distance Runner 2 reflected upon a visit to her GP, adding that “I have actually
6 been back to see her [general practitioner] and she did actually ask me directly, she said ‘have
7 you ever been diagnosed with an eating disorder?’”. The online diary entries and photographs
8 were then explored with probing questions, used to encourage further reflection and provide
9 additional insights into individual appraisals of psychological conflict (see Supplementary
10 File 1 for interview guide). Interviews lasted on average 68 minutes (range = 29–104
11 minutes) and were transcribed verbatim by the first author.

12 **2.4 Data Analysis**

13 Data were analysed in two separate stages in accordance with recommendations for
14 multiple-case study analysis (Stake, 2013). A within-case analysis approach was first used to
15 gain an overall sense of each athlete’s RED-S recovery experiences. Each participant’s data
16 were divided into two overarching datasets according to the RQs they sought to address. To
17 explore the psychological experience of recovery from RED-S (RQ1), data from the topical
18 life history and the follow-up stimulated recall interview pertaining to the initial interview
19 (e.g., reflections upon revisiting their visual timeline) were combined. To analyse the sources
20 (RQ2) and manifestations (RQ3) of psychological conflict associated with RED-S recovery,
21 all triggers of psychological conflict recorded in the online diary task, alongside their
22 associated responses and coping behaviours, were initially inputted into a separate
23 spreadsheet for each participant. Data from the follow-up interview that included reflections
24 on the online diary task and/or were associated with the photovoice task were added to the
25 participant datasets. Each participants’ psychological conflict spreadsheet was subsequently

1 compiled into a master spreadsheet, enabling an examination of similarities and differences
2 across the entire sample.

3 Both datasets were analysed inductively and thematically, guided by principles of
4 reflexive thematic analysis (Braun & Clarke, 2019). Data analysis began upon completion of
5 each initial topical life history interview and continued throughout data collection. In a
6 process of familiarisation (Phase 1), the interview transcripts were read twice, and audio-
7 recordings were replayed by the first author to create a detailed timeline for each participant
8 to use in the follow-up interview. To commence Phase 2, coding, the first author engaged
9 with the transcripts and online diary data, adopting a broad deductive approach (Braun &
10 Clarke, 2021) to segment relevant data pertaining to each research question. After identifying
11 data relevant to each RQ, an inductive approach was employed to construct initial *codes*,
12 which represented the most basic unit of analysis (e.g., an image of a weighing scale in the
13 photovoice task was coded as “preoccupation with body weight”). While the next three
14 stages, Phases 3-5, are explained sequentially, it should be noted that these steps took place in
15 a flexible fashion, with recursive shifts made between these stages throughout to ensure that
16 the analysis fitted well with the dataset (Braun et al., 2016). In Phase 3, theme development,
17 the first author interrogated the initial codes and compiled similar codes into preliminary
18 *themes*, which captured shared meanings or patterns across the data (e.g., the codes
19 ‘criticizing own appearance’ and ‘fixation with weighing oneself’ were represented by the
20 theme body image or weight concern). These themes were subsequently organised into
21 *domain summaries* (Clarke et al., 2019), which summarised the areas relevant to the three
22 RQs. The initial analytical framework was reviewed (Phase 4) by all members of the research
23 team (see below), with further refinements made following critical discussions between the
24 authors, which encouraged the first author to engage in further reflexivity (e.g., re-engaging
25 with data for each participant). After refining the analysis, the definitions and labels of the

1 domain summaries and themes were clarified (e.g., the domain summary “a constant tug of
2 war” captured manifestations of psychological conflict across the dataset, addressing RQ3),
3 with this process (Phase 5) supported by critical discussions with the other authors and
4 feedback received through the peer review process (see below). In Phase 6, producing the
5 written report, the analysis was written up (see below) and represent by three domain
6 summaries (“*In too deep and treading water*”: *The psychological experience of RED-S*
7 *recovery*; *Sources of psychological conflict*; “*A constant tug of war*”: *Manifestations of*
8 *psychological conflict*), with compelling participant quotes used to portray the psychological
9 experiences of the athletes.

10 **2.5 Rigor**

11 To enhance the rigor of our work, we drew upon a variety of recommended strategies
12 (e.g., Creswell & Miller, 2000; Smith & McGannon, 2018; Tracy, 2010). Throughout the
13 analysis process, the fourth author acted as a critical friend (Smith & McGannon, 2018),
14 challenging the first author’s interpretations of the datasets (e.g., questioning whether there
15 was sufficient data to justify “social media” being a stand-alone theme) and encouraging
16 further reflexivity and refinement of the analysis (e.g., raw data codes pertaining to social
17 media were combined with those indicating pressures from the general media, within the
18 theme “media influences”). Moreover, the research team engaged in regular peer debrief
19 meetings (Creswell & Miller, 2000) throughout the research process, wherein critical
20 decisions were made with regard to how to represent the findings within the final report (e.g.,
21 use of domain summaries as section sub-headings, selection of rich and evocative participant
22 quotes). Additionally, the findings were further developed through the peer review process.
23 For instance, it was suggested that the themes within the domain summary, “in too deep and
24 treading water”, required further development and refinement, with the initial themes of
25 *anxiety* and *depression* subsequently grouped into the theme *mental health concerns*. Finally,

1 a detailed audit trail was kept by the first author throughout data collection and analysis to
2 encourage ongoing reflexivity, while we also sought to provide thick descriptions through the
3 use of illustrative quotes in the representation of our findings (Tracy, 2010).

4 **3. Results**

5 The current study sought to explore qualitatively the psychological recovery journey from
6 RED-S in endurance athletes. The following sections present findings for each of the three
7 domain summaries, which were: *“In too deep and treading water”*: *The psychological*
8 *experience of RED-S recovery* (RQ1); *Sources of psychological conflict* (RQ2); and *“A*
9 *constant tug of war”*: *Manifestations of psychological conflict* (RQ3).

10 **3.1 “In Too Deep and Treading Water”: The Psychological Experience of RED-S** 11 **Recovery**

12 While the experience of RED-S recovery was characterised by ongoing attempts to
13 overcome its physiological consequences, participants also grappled with psychological
14 factors that directly undermined physical recovery efforts. Three themes represented the
15 psychological features of RED-S recovery (RQ1) generated across the sample, namely: *a*
16 *disordered mindset towards fuelling and exercise; suffering in silence; and something has got*
17 *to give.*

18 **3.1.1 A Disordered Mindset Towards Fuelling and Exercise**

19 This theme represented the DE attitudes and behaviours reported prominently in the
20 athletes’ accounts of their RED-S experiences and recovery efforts. When reflecting on initial
21 physiological outcomes of LEA (e.g., weight loss, performance improvements), three
22 participants recalled a concomitant onset of rigid and restrictive eating behaviours and
23 excessive exercise habits, while the remaining five athletes reported a worsening of pre-
24 existing DE/ED. As such, the recovery experience for each athlete was characterised by
25 attempts to overcome varying degrees of eating psychopathology, which had previously

1 maintained the cycle of LEA and eventually culminated in a deterioration of physical health
2 suggestive of RED-S. As Distance Runner 3 recalled: “I would have a 12-hour day at work
3 without any food basically, but I was happy with my weight loss and it was the first time ever
4 that I was slim, so that continued until I realised I couldn’t conceive”. Others recalled coming
5 to a realisation that their RED-S symptoms could have been initiated by maladaptive
6 cognitions towards fuelling and exercise (i.e., beliefs that they had previously held when
7 suffering with an ED prior to their engagement in their primary sports). For instance, when
8 suffering from an achilles injury and being unable to train, Triathlete 1 began to acknowledge
9 the intertwining relationship between her ED and increasingly more frequent engagement in
10 running: “it hammered home like ‘okay, sure the running is benefiting me in some
11 way psychologically, but it's still in some ways feeding into the eating disorder, so they aren't
12 completely separate things’”. Similarly, for Distance Runner 2, getting injured prompted her
13 to reflect upon why she was beginning to restrict her EI again:

14 When I got the injury I’d never thought all of that stuff about eating disorders was
15 gonna come out of it. I think that’s been the biggest thing to get my head around.
16 Actually there was a dark bit in the past that I hadn’t for a single minute thought was
17 something that was affecting me currently.

18 ***3.1.2 Suffering in Silence***

19 This theme captured other mental health concerns that were considered to be
20 concomitant with, or additional to, eating psychopathology, characterised by negative
21 emotions that were often concealed by the participants. For some athletes, adverse childhood
22 experiences, such as the loss of a loved one, or difficult interpersonal relationships appeared
23 to precede the onset of restrictive eating practices and/or excessive exercise regimes and
24 subsequent physiological symptoms of RED-S, issues that they were reluctant to disclose to
25 others. For instance, while Distance Runner 3 explained how identifying as a ‘fat child’ and

1 being regarded as such by her peers, both prompted and perpetuated a turbulent relationship
2 with food ('I thought because I was a fat child that's what I was gonna be, for life. I
3 massively comfort ate, so whatever was making me sad at home, I learnt to control it, by
4 controlling food'), Distance Runner 2 described how a difficult relationship with her
5 mother led her to conceal her own eating difficulties in her early teenage years:

6 My Mum was a catastrophiser, so very early on I learnt not to tell her things because I
7 worried more about her unhelpful response to it and I've kept that emotional
8 shutdown through my entire life. I had classic signs of Anorexia, but it was never
9 diagnosed, never discussed and in fact I never told anyone about it until this year.

10 For many participants, especially those identifying as still 'in-recovery', the prospect of
11 changing their eating and/or exercise behaviours following the onset of RED-S prompted
12 severe anxiety, as they began to acknowledge the health implications of their eating and/or
13 exercise habits and attempted to implement the changes necessary to improve EA in the long-
14 term. For example, when attempting to engage in more adaptive behaviours, Racewalker 1
15 explained: "It was quite scary, like almost having this fear of heights and someone telling you
16 you've gotta jump, so every time I ate was scary, a horrible feeling". Others described periods
17 of intense sadness and depression due to the overwhelming emotions elicited in response to
18 injuries or ill health, which compromised their sport involvement and daily functioning: "I
19 couldn't drive, I couldn't walk, and realised this is no longer just running, like my entire life
20 could be ruined. I thought 'this is grim, I can't even do anything'. I was massively low"
21 (Distance Runner 5). Concerningly, Distance Runner 2 described a critical moment at which
22 she felt so helpless and overcome with emotion that she experienced suicidal thoughts:

23 I had one run that I went out on and the cars were coming up the road and I had that
24 moment of thinking 'if I step out in front of these cars this can all be...gone, done...I
25 don't have to deal with it'.

1 *3.1.3 Something Has Got to Give*

2 This theme reflected how many participants described an ongoing psychological
3 trade-off between the seemingly opposing goals of achieving performance success, and
4 optimal health, thus creating the sense that something has “got to give”. Both women who
5 identified as “recovered” from RED-S outlined that “full recovery” required an element of
6 sacrifice in relation to their athletic pursuits. Whilst they continued to participate regularly in
7 distance running at the time of recruitment, they had previously made a decision to cease
8 competitive engagement in the sport and expressed hesitancy towards resuming performance-
9 focused training and competition in the future:

10 I'm unsure at this point in time whether I want to pursue competitive goals again,
11 because I'd probably have to put myself into a little deep hole [with regard to mental
12 health] to get back to there and I don't really wanna do that. I'd get so caught up in my
13 training that I'd then go back to the mindset of energy in, energy out and take steps
14 backwards, giving in to past behaviours [under-fuelling and excessive exercise]

15 (Distance Runner 1)

16 I do enjoy running but there is always that element of performance with it and I think
17 having had so much time off already I don't want to keep pushing myself harder for
18 performance just to be unwell and broken again, I just want to run and enjoy running.

19 (Distance Runner 4)

20 Others, including Climber 1, demonstrated uncertainty as to whether they could continue
21 competing at a high level within their sports whilst maintaining optimal health: “I'd decided
22 that if it's health or climbing, I'd choose health, and that's fine but it's almost like this carrot-
23 dangling of ‘you can have both’ and I'm just not sure, in a weight-dependent sport that you
24 can”. As such, this theme reflected the seemingly paradoxical pursuit of both optimal health,

1 which requires adequate EA and physical recovery, and optimal endurance performance,
2 which may be perceived as necessitating a lean physique and arduous training schedule.

3 **3.2 Sources of Psychological Conflict**

4 A total of 73 triggers of psychological conflict were recorded in the online diaries (M
5 $19 = 3$ per participant per week; range = 0-8) and 27 photos were taken (M photographs per
6 participant = 3; range = 0-8). Two participants did not complete the photovoice task, either
7 due to time constraints ($n = 1$) or to circumvent the potential for psychological distress ($n =$
8 1). The triggers were organised into seven themes reflected within the domain summary,
9 sources of psychological conflict (RQ2; Table 2). All participants reported that *decisions*
10 *concerning exercise volume* elicited psychological conflict, as engaging in activities of lower
11 intensity or lower perceived energy expenditure to aid recovery, could prompt subsequent
12 restrictive eating behaviour. Triathlete 1 described having difficulty refraining from higher
13 volumes of exercise:

14 I'm currently working to a very loose plan to help me build some base fitness, which
15 is about half as many hours a week as I would do during peak weeks [those leading up
16 to a big competition]. I have been finding it quite difficult to justify this in my mind
17 and resist the urge to do more, unhealthy exercise.

18 The majority of the athletes also reported *body image or weight concerns* ($n = 7$), whereby
19 situations that caused them to reflect upon their body size or shape, or compare it to others,
20 also had the potential to heighten maladaptive eating and exercise intentions. As Climber 1
21 described in a diary entry:

22 I've generally just pressing on but have been given the green light to do some
23 exercise, so I feel excited but also apprehensive about that. I feel unsure about how
24 my "new body" will feel in a sport I am so used to feeling strong and light doing.

1 Similarly, *eating opportunities* (e.g., mealtimes, social gatherings involving food) resulted in
2 many participants ($n = 7$) questioning the volume of food to be consumed, the content and
3 nutritional value of different food options, and whether to eat at all. As Distance Runner 3
4 noted in her diary:

5 I've had very good energy levels but not a very big appetite, which has made it
6 difficult to feel I need to eat. I've also been very busy which is tricky when it comes
7 to eating and resting enough.

8 Furthermore, *media influences*, including social media platforms, physical activity
9 applications, news articles, and bulletins appeared to increase many of the athletes' ($n = 5$)
10 negative thoughts towards their bodies and capabilities. As Triathlete 1 described in her
11 follow-up interview, when reflecting upon one of her photographs: "I hate this [Instagram
12 post from a peer about their athletic achievements] it makes me angry, feels braggy, I feel I'm
13 not doing enough, I should go out ACHIEVE ACHIEVE ACHIEVE. I feel insignificant, like
14 I'm underperforming". Additionally, a number of participants ($n = 3$) reported *physical*
15 *symptoms associated with RED-S* (e.g., menstrual irregularity, recurrent injury, illness) and
16 *professional education and advice* (e.g., seeking psychological support, working with a
17 Dietician), which both elicited psychological discomfort, but often subsequently resulted in
18 adaptive behavioural outcomes (see section 3.3.4). Finally, three athletes recorded triggers
19 relating to *social interactions* (e.g., observing a friend's eating habits, social gatherings,
20 interactions with teammates), as these often prompted self-deprecation or feelings of
21 inadequacy. Collectively, the triggers manifested in a multitude of thoughts, feelings, and
22 coping behaviours, which influenced the ongoing management of EA (see below).

23 [INSERT TABLE 2 HERE]

1 **3.3 “A Constant Tug of War”: Manifestations of Psychological Conflict**

2 This domain summary captured the reported cognitive, affective, and behavioural
3 responses to psychological conflict in the management of EA (RQ3). Together, the four
4 themes generated represented the combination of incongruent thoughts, feelings, and
5 behaviours associated with managing EA, which appeared to give rise to a psychological
6 battle between motivations to persist with increased EI and/or reduced EEE to improve
7 physical health, and reservations about doing so. Table 3 provides an overview of the themes,
8 codes, and example raw data quotes from the stimulated-recall interviews pertaining to the
9 online diary and photograph data.

10 [INSERT TABLE 3 ABOUT HERE]

11 **3.3.1 “In Two Minds”: Cognitive Responses to Psychological Conflict**

12 The theme “in two minds” represented the cognitive responses reported by
13 participants in instances of psychological conflict. Upon encountering psychological conflict
14 in their ongoing management of EA, participants reported a persistent battle between
15 beneficial and harmful beliefs regarding EI and EEE. When conflict arose, some engaged in
16 internal dialogue to rationalise or justify the actions needed to facilitate recovery, as Distance
17 Runner 1 described: “It's justification. I have to justify to the negative part of myself why I'm
18 doing something...when something else tells me I shouldn't do it”. Distance Runner 2 echoed
19 this when remarking:

20 Making things better is harder, because I have to work through why I'm running or
21 overexercising, or don't want to eat. Sometimes I feel in my head that I've got the
22 breaks on and it'd far be easier to just stop eating, but I have to tell myself, “the best
23 thing you can do right now is look after yourself”.

24 Others explained how sources of conflict that increased their knowledge of EA prompted
25 self-reflection and a motivation to challenge past behaviours that led to RED-S: “It [RED-S

1 education event] just reiterated the fact that surely I should have known, I should've done
2 something earlier and now could be better... it makes me annoyed but keen to change”
3 (Racewalker 1). In contrast, this self-evaluation and comparison to a ‘previous self’ was
4 detrimental for others, who used disparaging language to describe changes in their
5 appearance or perceived capabilities since beginning their recovery journey: “I don’t look
6 like me anymore. I’m really soft and wobbly. My boobs are massive and the styles I like look
7 different on me. I want to hide my body” (Climber 1). This self-deprecation was common
8 across the participants, both when they successfully engaged in positive EA behaviours or
9 fell short of their recovery expectations. Indeed, many of the triggers created **ambiguity** as to
10 what was the “right way” to look, eat, or exercise, leaving the athletes questioning their
11 bodies, appetite, and/or exercise volume. For example, Distance Runner 1 questioned
12 whether her body conformed to perceived necessary requirements of participation within her
13 sport: “I’m just not sure I’m the right size and shape to be a good runner”. Similarly, Distance
14 Runner 3 reported questioning her feelings of hunger in one of her online diary entries: “Why
15 am I hungry? I'm not sure I ‘deserve’ to be hungry”. Together, contradicting thoughts in
16 times of psychological conflict contributed to a perceived lack of clarity as to how to behave
17 with regard to managing EA.

18 ***3.3.2 “An Emotional Rollercoaster”:*** *Affective Responses to Psychological Conflict*

19 Intrusive and conflicting thoughts surrounding management of EA appeared to evoke
20 a multitude of unpleasant emotions, which at times became overwhelming and difficult to
21 contain. This notion of “an emotional rollercoaster” was reflected in Distance Runner 2’s
22 diary entry during a week in which she severely restricted her food intake due to stress:

23 I couldn’t even open my mouth to speak. I could’ve clung to the ceiling. The anxiety
24 and emotions were just so strong. Feeling really frustrated and a sense of hopelessness
25 because I'm stuck in a vicious cycle of exercise addiction and anxiety around food.

1 Feelings of fear and anxiety were frequently associated with decisions about eating and
2 exercise or seeking professional advice, as Distance Runner 2 described following a
3 supermarket trip:

4 That was a little traumatic. Sometimes I go in there and just wanna cry. It's like the
5 pressure of choosing what to eat. It made me really angry and sad. I had tears in my
6 eyes and could easily have had a massive meltdown.

7 Shame and disgust were also described, and accompanied by feelings of guilt, when athletes
8 engaged in a positive EA behaviour (i.e., taking a rest day or eating more than initially
9 planned), despite it facilitating their physical recovery. As Distance Runner 3 commented in
10 her diary in response to a friend's social media post following a successful sporting
11 performance, "[I am] beating myself up, feeling lazy and useless and ashamed". Furthermore,
12 negative appraisals of body weight or recovery progress often initiated feelings of disgust or
13 disappointment. Climber 1 said: "I look hideous due to weight gain...I body-checked a lot
14 but then felt frustrated at myself for it". Conversely, some athletes recalled experiencing
15 pleasant emotions of happiness or hope when spending quality time with friends or reflecting
16 on successful recovery progress: "I had this enormous sense of achievement and wellbeing
17 and I was very emotional with this sense of pride in myself" (Triathlete 1). Pleasant emotions
18 were, however, reported amongst fewer participants ($n = 4$) than unpleasant emotions ($n = 8$).
19 More often, pleasant emotions were recalled during the photovoice task in the follow-up
20 interview as several athletes had taken photographs of objects or situations, which, despite
21 initiating psychological conflict, ultimately reinforced their recovery efforts:

22 I stopped to take a photo (laughs), which I don't normally do, because my Strava was
23 running. It was sunset, I was feeling quite positive in my mind about all of this and I
24 felt like that was more important. It was good. (Distance Runner 3)

1 Overall, the majority of emotions experienced in response to psychological conflict were
2 negative and ultimately shaped subsequent behavioural responses to management of EA.

3 **3.3.3 “Giving in”: Maladaptive Behavioural Responses to Psychological Conflict**

4 This theme represented instances when participants succumbed to engaging in
5 ‘unhealthy’ exercise and eating habits, which were reported by most athletes ($n = 6$).
6 Participants conveyed a despondency that often resulted in the avoidance of positive EA
7 behaviours, which involved succumbing **to** restrictive eating and/or increased exercise
8 volume. For example, Racewalker 1 said, “if I have a particularly bad day and feel anxious, it
9 could be anything, but I’ll end up eating less than I should”. Additionally, Distance Runner 2
10 recalled acknowledging a need to rest her body, but continued to exercise nonetheless:

11 Despite being physically worn-out, I went to the gym. I felt exhausted, energy-less
12 but I carried on. I knew that the best thing for my health would have been to rest, take
13 some time to cook and eat and generally nurture myself... but the exercise has such a
14 tight grip on me.

15 Others also denied the need to increase EA, prompting them to override their rational
16 thoughts and engage in maladaptive behaviours, as Climber 1 described:

17 Before my period returned, I felt I had almost a medical reason to throw out my food
18 rules, like “well I'm really unwell so I need to sort it out” ... but that felt harder once
19 my period was back ‘cause I was like “well now I'm healthy again maybe I should
20 keep an eye on my portions”. It's a slippery slope.

21 The maladaptive coping behaviours described by the participants threatened to derail
22 recovery progress by increasing the likelihood that LEA would be re-initiated.

1 **3.3.4 “The Only Way is Through”:** *Adaptive Behavioural Responses to Psychological*

2 *Conflict*

3 This theme represented adaptive behavioural responses to psychological conflict.
4 Successful efforts to engage in positive EA behaviours reflected a perseverance in the face of
5 psychological discomfort. Distance Runner 5 remarked on the need to consistently maintain
6 recovery efforts: “You just have to kind of keep going. It's not like ‘oh I've now like taken
7 this exam or I've passed this finish line’ kind of thing. It can always go backwards if you
8 don't just make the effort”. Some participants employed psychological strategies, such as
9 thought-stopping, to persist with positive behaviours: “I think they [negative thoughts] are
10 always gonna be there but I'm much more able to kind of park that and put it to one side now,
11 not let it impact my actions” (Distance Runner 4). For some, vocalising irrational or
12 unhelpful thoughts by talking to others also appeared to lessen the severity of negative
13 emotions, reducing the likelihood of undesirable EA behaviours: “the psychologist helped me
14 understand that it [recent relapse into restrictive eating] was okay and we just needed to keep
15 an eye on triggers for it” (Distance Runner 2). By engaging in discussion with others, this
16 offered a degree of accountability for some, as Triathlete 1 described when feeling anxious
17 about missing a run she had initially planned: “I told my boyfriend my decision which held
18 me accountable and helped me feel less guilty about not going out.” For others, writing notes
19 or lists of necessary actions facilitated recovery progress. More often than not, strategies that
20 encouraged heightened self-awareness of tendencies to adopt LEA behaviours during
21 stressful situations enabled participants to persist with increased energy intake and/or reduced
22 exercise volume. Despite feelings of frustration, and often despair, the participants
23 demonstrated an acceptance of their RED-S experiences, which appeared to facilitate
24 ongoing recovery efforts: “I'm quite angry at the fact I'm still getting stress fractures so
25 easily, like 15 years down the line, but I think I've got quite good at just accepting the stuff

1 that I just can't change” (Distance Runner 4). Distance Runner 2 described how seeking
2 psychological treatment following her physical presentations of RED-S was crucial in
3 supporting her long-term recovery:

4 I had to go through that process of it being hard and making mistakes and then letting
5 people help me. If somebody had said ‘right we’ll put you on bed-rest for eight
6 weeks, we’ll tube feed you, you’ll put on the weight and you can set off running
7 again’, I’d have never dealt with these psychological problems.

8 Collectively, these strategies represented the perceived adaptive behavioural responses that
9 appeared to facilitate improvements in EA.

10 **4. Discussion**

11 This study aimed to explore qualitatively the psychological experience of recovery
12 from RED-S in endurance athletes. By using an integrated qualitative method and capturing
13 data in relation to recovery from RED-S in information-rich cases, findings contribute new
14 insights into the psychology of RED-S, particularly the negotiation of ongoing psychological
15 conflict in pursuit of optimal EA. In turn, this study advances understanding of the proposed
16 reciprocal relationship between LEA and psychological health (Mountjoy et al., 2014) by
17 elucidating how a persistent cycle of LEA appeared to contribute to physical consequences
18 associated with RED-S, which prompted the worsening or onset of DE behaviours,
19 depression, and anxiety. Whilst the findings support the suggestion that sport participation
20 could be used as leverage to motivate athletes in recovery from RED-S (Mountjoy et al.,
21 2018), it also appeared that symptoms of RED-S may create psychological conflict between
22 eating and exercise practices that are perceived to benefit performance and those that promote
23 long-term health. Furthermore, this study advances previous work describing a state of
24 psychological conflict encountered during attempts to ‘recover’ from RED-S among
25 endurance athletes (Langbein et al., 2021) by providing accounts of how such conflict is

1 experienced, and responded to, in a purposive sample of female endurance athletes who
2 identify as ‘in recovery’ or ‘recovered’ from RED-S.

3 The psychological experience of recovery from RED-S was difficult to distinguish
4 from efforts to recover from DE/ED cognitions and/or behaviours, which, for some athletes,
5 were reported to occur after LEA onset. As such, the findings provide evidence for the
6 contention that LEA may precede psychological concerns (Mountjoy et al., 2014) and aligns
7 with past research that reported the onset of DE/ED following illness or injury, changes in
8 body weight or shape, and/or the adoption of rigid or restrained eating (Arthur-Cameselle et
9 al., 2017). Moreover, anxiety and depression were commonly reported as a result of concerns
10 with weight gain, appearance, and/or dejection associated with abiding by highly controlled
11 and rigid eating and exercise routines. In light of this finding, it could be suggested that
12 symptoms of anxiety and depression reported across the sample were not a direct
13 consequence of LEA *per se*, but a correlate of eating psychopathology, similar to previous
14 research (Ackerman et al., 2019; Shanmugan et al., 2014). Furthermore, the findings also
15 provide support for the potential utility of cognitive dissonance theory (Festinger, 1957), in
16 that psychological conflict was reported in response to triggers centered around decision-
17 making (e.g., exercise volume) and, in some cases, expert recommendation, whereby athletes
18 were instructed by health and/or sports medicine personnel to engage in behaviours (i.e.,
19 increase EI and reduce EEE) that were incongruent with their maladaptive thoughts.

20 With regard to the manifestations of psychological conflict, all participants reported
21 ongoing maladaptive cognitions towards food, exercise, and their bodies, regardless of
22 whether they identified as psychologically and physically ‘recovered’ or not. The persistence
23 of disordered cognitions that could threaten recovery progress and increase risk of relapse -
24 despite the presence of observable physical recovery indicators - has previously been referred
25 to as a state of “pseudo-recovery” in the context of ED (Bardone-Cone et al., 2018). In turn,

1 this suggests that the predominantly medical model applied to recovery from implications of
2 LEA (Mountjoy et al., 2015) may struggle to adequately detect and address psychological
3 issues that could prevent long-term physical and psychological recovery from RED-S.

4 The findings also build on previous research identifying negative emotions as a factor
5 that hinders recovery efforts from ED in athletes (Arthur-Cameselle & Quatromoni, 2014) by
6 offering novel insights into the behavioural manifestations of negative affect within the
7 broader context of RED-S. The maladaptive behavioural coping strategies employed in
8 response to psychological conflict appeared to be driven by a desire to avoid negative
9 emotions and may be regarded as emotion-focused coping strategies (Lazarus & Folkman,
10 1984). In contrast, adaptive behavioural responses, such as thought-stopping and
11 accountability, appeared to involve problem-focused coping strategies (Lazarus & Folkman,
12 1984), which facilitated improvements in EA by encouraging increased EI and/or reduced
13 EEE. Similar to previous work (Arthur-Cameselle & Quatromoni, 2014), adaptive coping
14 strategies exemplified ways in which participants were able to express, and make sense of,
15 their emotions, rather than suppressing or seeking to alleviate them by pursuing restrictive
16 eating and/or excessive exercise. Thus, the findings suggest that supporting athletes with
17 RED-S to develop and adopt problem-focused coping strategies may help to maintain optimal
18 EA.

19 **4.1 Applied Implications**

20 Findings in this study could have several applied implications. First, given that the
21 psychological experience of recovery from RED-S was characterised by self-identified or
22 clinically diagnosed eating psychopathology, addressing coexisting psychological concerns is
23 important, especially as psychological wellbeing and altered cognitions have been identified
24 as fundamental criteria for recovery by recovered ED patients (de Vos et al., 2017). Thus,
25 education interventions that seek to help athletes to moderate triggers of psychological

1 conflict identified in this study and facilitate changes in cognitions could be vital for
2 promoting improved psychological wellbeing for those with and without evident eating
3 concerns. Second, raising awareness of potential triggers of psychological conflict could help
4 coaches and support staff to foster an environment that seeks to circumvent their initiation.
5 Indeed, it was noteworthy that professional advice and support appeared to trigger
6 psychological conflict, yet often resulted in adaptive behavioural responses to managing EA,
7 and a shift in mindset to align with such behaviours. This suggests that support personnel
8 should be aware of the potential impact of their interactions on athletes in recovery from
9 LEA. Finally, the study supports calls for a multidisciplinary approach, incorporating both
10 physiological assessment and psychological support, to detect, appropriately treat, and
11 prevent future onset of RED-S (Thein-Nissenbaum & Hammer, 2017).

12 **4.2 Strengths, Limitations and Future Directions**

13 This integrated qualitative study exploring the psychological experience of ‘recovery’
14 from RED-S in athletes has several strengths, including: the collection of data via multiple
15 sources at different points in time and the methodological procedures employed to enhance
16 rigour. Despite these strengths, there are a number of limitations that should also be
17 acknowledged. Firstly, we appreciate that the findings do not capture objective indices of
18 RED-S, nor can they confirm whether psychological health concerns resulted from a
19 physiological state of LEA, or from pre-existing eating psychopathology. However, as we
20 sought to explore subjective experiences of RED-S recovery, physiological measures of LEA
21 at the time of data collection would not have appropriately addressed our RQs. Secondly, as
22 the study did not recruit participants on the basis of the presence or absence of DE/ED, we
23 were unable to explore isolated accounts of inadvertent or intentional LEA that occurred in
24 the absence of DE/ED. Thus, future studies could seek to recruit individuals who do not meet
25 ‘at-risk’ or diagnostic criteria for DE/ED. Finally, results from our female-only sample

1 cannot be deemed representative of the male experience of RED-S, and the findings may not
2 be reflective of individuals participating in different sport and exercise contexts. Despite this,
3 the findings of this study could achieve naturalistic generalisability, as the accounts and
4 experiences of the participants may resonate with readers who are also endurance athletes
5 (see Smith, 2018). Furthermore, the findings could demonstrate transferability to applied
6 sports medicine settings (Tracy, 2010), whereby the findings could be valuable for
7 professionals who work with athletes and seek to facilitate optimal health and performance.
8 Future studies should recruit both male and female participants across a broader range of
9 physical pursuits, to explore LEA and RED-S among the wider active population.

10 **5. Conclusion**

11 The aim of this study was to explore qualitatively the psychological experience of
12 recovery from RED-S in endurance athletes. Our findings suggest that the onset of RED-S
13 may create psychological conflict between an athlete's desire to maintain optimal health to
14 continue in their sport, and the perceived necessity of maladaptive behaviours that are
15 considered necessary to facilitate physical performance. As sport-specific and wider lifestyle
16 triggers appeared to make physical recovery progress from RED-S more difficult, this
17 highlights a need to address psychological concerns alongside efforts to promote physical
18 recovery if future behaviours that initiate a cycle of LEA are to be prevented in the long-term.

19

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1 **Table 1**

2 *Participant demographic and RED-S experience characteristics.*

Participant (pseudonym)	Age (during study)	RED-S 'diagnosis'	Age at RED-S onset	Competitive level at time of RED-S 'diagnosis' (Swann et al. 2015 criteria)	Additional sport/exercise during RED-S experience	Self-reported 'recovery' status ¹	Time since recovery commencement ⁴
Distance Runner 1	23	Self	17	National (semi-elite)	Strength training, cycling	Psychologically and physically recovered	4 years
Distance Runner 2	38	Sports medicine professional	37	Club (sub-elite)	Strength training and fitness classes (gym)	In recovery	2 years
Racewalker 1	26	Self	18	National (semi-elite)	Endurance running, track athletics, gym, cycling	In recovery	1 year
Distance Runner 3	35	Self	34	Club (sub-elite)	Fitness training and classes (gym), cycling	In recovery	1 year
Triathlete 1	26	Self	19	Club (sub-elite)	Strength training (gym)	In recovery	2 years
Climber 1	32	Sports medicine professional	17	National and international (competitive-elite)	Running, open water swimming	In recovery	6 months
Distance Runner 4	30	Self	15	National and International (semi-elite)	Cycling, swimming, yoga	Psychologically and physically recovered	15 years
Distance Runner 5	28	Sports medicine professional	18	National and International (semi-elite)	Cycling	In recovery	3 years

Note: ¹ The athletes referred to recovery as a period in which they acknowledged the need to improve their energy intake and/or exercise volume and actively pursued increases in overall EA with view to overcoming physical and psychological symptoms associated with RED-S.

1 **Table 2**

2 *Sources of psychological conflict associated with managing energy availability*

Theme	Example triggers	Experience of psychological conflict (raw data quote)
Body weight or shape	Breasts feel larger than usual in my sports bra; tried on wedding dresses; seeing myself in the mirror;	Nervous about being around people who I haven't seen for a while, questions or seeing me looking bigger/different (Climber 1)
Eating opportunities	Having no appetite; hungrier than usual; stomach conflict issues; unable to train;	Now that I have had a good couple of weeks of eating I start to reach a bit of a nervousness about keeping it up and it's also where the low-level anxiety of eating too much starts to kick in and I feel like I need to put the brakes on a bit (Distance Runner 2)
Exercise volume	Strava training log; deciding between a walk or gym session; a weekend without any exercise;	Good! Need to get a little more comfortable with resting but it doesn't mean that I haven't allowed myself a lot of rest. But I do always have this feeling of 'I should be working harder and doing more' (Distance Runner 5)
Media influences	Social media post about Olympics; documentary about restricting food groups; Instagram post by athlete friends; RED-S Facebook group	When I see the post I feel small, I feel like an imposter, I immediately compare my own performances. There is an inherent sense of competition even when there is none, as if I do not matter unless I am performing well (Triathlete 1)
Physical symptoms associated with RED-S	Late period; performance in running race; seeing others running but you can't; completely off sport and can't even cross-train	I want to go for a decent walk because I don't wanna just be sat on my bum all day but actually then if I did go and do a long walk there would be that guilt about it making the injury worse or not giving it the time to heal and then you worry about whether it's going to be three or four weeks or if it's going to be more like five or six weeks. (Distance Runner 4)
Professional education and advice	Meeting with Dietician; attending a lecture on nutrition; a day of talks about RED-S; meeting coach	So she [dietician] suggested having a sports drink when I go to the gym, just to try and sneak in extra calories, but I still find it quite hard. Like if I was going on a massive run, I would. But when I've hardly broken out in a sweat just doing a few weights I'm like 'really do I need to?' (Distance Runner 2)
Social interactions	Seeing my friend's meal; going out for work Christmas do; spending time with friends	I'm still feeling a little uncomfortable about not being able to train as much and I'm spending the weekend with a friend who is currently struggling with eating so I'm actively trying to promote healthy eating patterns while I'm with her (Distance Runner 4)

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1 **Table 3**

2 *Themes, codes, and example raw data quotations for the domain summary “manifestations of*
 3 *psychological conflict”.*

Example raw data quotations	Codes	Theme
Have been struggling way too long; caused myself to miss out on potential; keen to tackle underlying issue.	Internal dialogue and self-reflection	In two minds - cognitive characteristics of psychological conflict
Learning how I can improve my performance; this will help me eat more sensibly around activity; realise I wasn't eating right.	Improved knowledge and self-awareness	
I look weak; fat and heavy; so much larger than my friend; not working hard enough.	Self-deprecation	
I don't know how to follow hunger cues; don't know if I need to fuel after cycles.	Ambiguity	
Feeling genuinely happy realising there is still a big part of me that can be happy; slightly positive for the second time in a long time.	Happiness/contentment	An emotional rollercoaster - affective responses to psychological conflict
Stressed, compulsive; uneasy; tense; apprehensive; overwhelmed; worried; scared; on-edge.	Fear	
Gross; fat; disgusted; lazy and useless; imposter; unathletic; unfit.	Shame/disgust	
Sad and wishing I could not care about my weight; disappointed in myself.	Sadness	
I've pretty much had every symptom, and like, they aren't gonna go away overnight so I just have to keep pressing on with recovery	Perseverance	The only way is through - adaptive behavioural responses to psychological conflict
I just don't ever wanna go back into that space and if it means I can't climb or won't be a professional athlete then okay.	Acceptance	
I said "thank-you but no thank-you" to the thoughts and got on with it; tried to forget about the difficult thoughts and allowed myself to enjoy the moment	Thought-stopping	
I dithered over the decision but once I'd made the decision not to do it I told my boyfriend my decision which held me accountable and helped me feel less guilty.	Accountability	
Trialling having something like yoghurt with banana soon after each run; drank some water and made some food for myself.	Increasing energy intake	Giving in - maladaptive behavioural responses to psychological conflict
I adapted the exercises to reduce impact and as I was doing it I realised that feeling strong, happy and healthy is better than feeling rubbish.	Reducing exercise volume	
I started to keep the food diary and gradually I was eating less cause I liked the numbers showing up less than recommended; I ate but ate quickly and only a small amount.	Restrictive eating	
I checked and tallied up all the hours I've done over the last two weeks and decided to increase next week.	Increased exercise volume	

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