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ORIGINAL ARTICLE

# Does weight change relate to psychological variables and eating behaviours in combat sports?

**Sónia Gonçalves[1] · Amadeu Ribeiro[1] · Sílvia Félix[1] · António Rui Gomes[1]**

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## Abstract

**Purpose** Athletes who perform combat sports tend to engage in weight-management strategies to fit in a specific weight class that are characterized by disordered eating behaviours. This study aimed to (1) characterize eating behaviours and adaptation to stress regarding an unwanted weight change before a competition; (2) evaluate the differences between athletes who consider unwanted weight changes as a challenge or as a threat in regard to emotions, coping strategies and eating behaviours; and (3) evaluate whether some of these variables related to the unwanted weight change (e.g., emotions, cognitive appraisal of the situation) are predictors of disordered eating behaviours in combat sports.

**Methods** A total of 166 combat sports athletes (75.3% male), aged between 14 and 56 years (M = 22.73; SD = 8.03), filled out a set of questionnaires that evaluated personal variables, cognitive appraisal (threat/challenge), coping, emotions, and eating behaviours related to an unwanted weight change before a competition.

**Results** Most of the athletes (57.3%) reported high levels of stress related to the experience of an unwanted weight change before a competition. Athletes who perceived this experience as more of a threat had significantly more eating concerns, anxiety, dejection, anger, active confrontation and emotional support. Athletes who perceived it as more of a challenge experienced more excitement and happiness. Athletes who perceived a high threat and low challenge experienced significantly increased anxiety levels and athletes who perceived this experience as a low threat and the low challenge had decreased anxiety. The desire to weigh less, the perception of a threat regarding weight changes, the ability to cope with denial, and anxiety emerged as predictors of disordered eating behaviours.

**Conclusion** To prevent or reduce disordered eating behaviours, it is important to promote adequate strategies to deal with weight changes before a competition and, consequently, positive emotions among sports combat athletes.

**Level of evidence** Level III, case-control analytic study.

**Keywords** Combat sports · Eating behaviour · Stress · Cognitive appraisal · Emotions

## Introduction

Physical activity has been consistently associated with improvements in wellbeing, physical and mental health, and the prevention of some diseases (e.g., diabetes, cardiovascular and respiratory diseases) [1–5]. Notwithstanding, the research also suggests that athletes are more at risk of engaging in disordered eating behaviours than the non-athlete population [6–8]. Furthermore, their prevalence is higher among athletes competing in sports focusing on leanness and weight (such as combat sports) compared to athletes competing in other sports [6, 7, 9].

Combat sports athletes are classified according to their weight in an attempt to reduce potential injuries and to promote impartial fights between combatants well-matched in body size, strength, and agility [10, 11]. The literature has shown that rapid weight loss strategies are highly prevalent among combat sports athletes [11–14]. Nevertheless, rapid weight loss strategies include disordered behaviours such as reduced liquid ingestion and food intake, saunas, plastic suits, not eating all day prior to the weigh-in, induced vomiting, diet pills, laxatives, and diuretics that are all associated

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✉ Sónia Gonçalves
sgoncalves@psi.uminho.pt

[1] School of Psychology, University of Minho, Campus Gualtar, 4710-057 Braga, Portugal

with adverse effects on health status [11, 12, 15–17]. Moreover, initial research about weight loss and weight regain in wrestlers suggests that combat sport athletes also present high frequencies of loss of control over eating [18]. These dysfunctional behaviours occur as an attempt to reduce their body mass to a weight class 5–10% below their normal body weight, which will presumably contribute to an advantage over the opponent and increase their chances of success [11, 15, 16, 19].

A weight change before a competition could be perceived as a stressor for athletes by making them unable to compete in the desired weight class. This can make combat sports more problematic in terms of stress experienced by the athletes. However, to understand the experience of stress in sports, it should be considered not only in the sports context but also in regard to the personal characteristics of the athletes. According to Lazarus' Transactional Model [20], stress emerges from the relationship between the cognitive appraisal of the situation (primary cognitive appraisal) and the perception of coping strategies available to deal with the situation (secondary cognitive appraisal). The primary cognitive appraisal indicates whether the situation will be perceived as a threat or as a challenge. The cognitive appraisal of stressors as more threatening occurs when the situation is experienced as too demanding to be dealt with by the capabilities of the individual [21].

Threat perception generally leads to a higher stress perception, less effective coping strategies [22], negative emotions (e.g., anxiety, sadness, anger) [23], and poorer outcomes, such as bulimic symptoms [24]. On the other hand, the cognitive appraisal of a challenge occurs when the situation is perceived as possible to overcome and within the individual's capabilities [21]. Challenge perception generally leads to less stress perception, more effective coping strategies [22], and positive emotions (e.g., excitement, joy) [23]. Moreover, previous research suggests that it is only possible to feel a threat or challenge when a situation is perceived as important by the individual [25].

The secondary cognitive appraisal includes the coping strategies, which are subdivided into problem-focused and emotional-focused coping. The problem-focused coping consists of doing something to deal with the stress and includes strategies such as active confrontation (i.e., taking active steps to resolve the situation) and humour (i.e., using humour to handle a stressful situation). Emotional-focused coping targets reduction of the emotional distress associated with the stress situation and includes denial (i.e., denying the existence of a stressor) and emotional support (i.e., seeking social support to deal with emotional distress) [26–28].

The literature concerning the role of cognitive appraisal in adaptations to stress and about the association between emotions and disordered eating behaviours in combat sports athletes is scarce. In addition, the existing studies tend to analyse the stressful situation, emotions, and coping strategies independently because of the greater ease of data analysis [23]. Hence, in our study, we simultaneously analysed psychological variables regarding human adaptations to stress (i.e., cognitive appraisal, coping strategies, emotions) and eating behaviours in combat sports athletes using critical incident methodology [29] that analysed how athletes evaluate and adapt to a stressful situation (having an undesirable weight change before the competition). This methodology adopts a closer approach to the situation and has been employed in studies about adaptation to stress [30, 31]. Three specific goals for the study were established:

1. Characterize eating behaviour and adaptation to stress regarding an unwanted weight change before the competition.
2. Analyse differences in psychological and eating behaviour variables as a function of the primary cognitive appraisal of an unwanted weight change before the competition.
3. Identify if the personal variables of athletes and their psychological experiences regarding an unwanted weight change before competition predict disordered eating behaviours.

We hypothesized that athletes who appraise an unwanted weight change as a threat would exhibit more negative emotions and emotion-focused coping and conversely, athletes who appraise an unwanted weight change as a challenge would present more positive emotions and problem-focused coping. Additionally, threat perception, less adaptive coping strategies and negative emotions related to the unwanted weight change predict disordered eating behaviours.

## Methods

### Participants

The sample was comprised of 166 federate athletes (75.3% male) recruited in sports clubs. The participants were aged between 14 and 56 years (M = 22.73; SD = 8.03). All participants were practising either karate ($n = 64$; 38.6%), kickboxing ($n = 49$; 29.5%), judo ($n = 38$; 22.9%), taekwondo ($n = 7$; 4.2%), Muay Thai ($n = 2$; 1.2%), boxing ($n = 1$; 0.6%), or jiu-jitsu ($n = 1$; 0.6%). Participants had a mean 7.14 years (SD = 5.54; Min = 1; Max = 44) of competition experience and the majority ($n = 118$; 71.3%) had won at least 1 championship: 72 (43.4%) national champions, 38 (22.9%) regional champions and 9 (5.4%) international/world champions.

## Procedure

This study was approved by the Ethics Committee of the University of Minho (SECSH 043/2016). Data collection involved obtaining permission from the directors of sports clubs and contact with athletes to explain the goals of the study, the confidentiality, and the voluntary nature of participation. Athletes who accepted participation first signed informed consent and then completed an evaluation protocol of eating behaviours, stress perception, cognitive appraisal, coping strategies, and emotions. The return rate of the questionnaires was 83%.

To assess adaptation to stress, a critical incident methodology was applied by confronting athletes with a hypothetical situation: "Imagine that one week before an important competition, your weight changes in relation to your desired weight class. This change occurs against your will".

## Measures

The evaluation protocol was based on instruments already used in the Portuguese population. However, due to the nature of this study (critical incident methodology related to an undesirable weight change), the instructions and items were slightly changed to ask athletes to fill out the instruments after just thinking about this situation. No other changes were made to the instruments.

*Personal and Sportive Questionnaire* This instrument was developed for this study, and it evaluated personal information such as sex, age, weight desired, information about the sport practised such as weight class, and awards obtained.

*Primary and Secondary Cognitive Appraisal Scale (PSCAS)* [32] For this study, the original 12-items scale [33] was adapted to a specific version that evaluated the athletes' three subscales of primary cognitive appraisal related to an undesirable weight change: (a) situation importance (three items; $\alpha = 0.87$ for this study; "Having an undesirable weight change would be something…. not important to me/very important to me"); (b) threat perception (three items; $\alpha = 0.89$ for this study; "Having an undesirable weight change would be something…. not disturbing to me/very disturbing to me"); and (c) challenge perception (three items; $\alpha = 0.72$ for this study; "Having an undesirable weight change would be something…. not stimulating to me/very stimulating to me"). Each item was measured on a 7-point Likert scale (0 = means nothing to me; 6 = means a lot to me). High scores on each subscale indicate greater importance, threat, and challenge perceptions.

*Sport Emotion Questionnaire (SEQ)* [34, 35] This 22-item instrument was used to evaluate the athletes' emotional responses to a sporting event (i.e., in our case, related to an undesirable weight change) in five dimensions: anxiety (five items; $\alpha = 0.84$; "Having an undesirable weight change would make me feel anxious"), dejection (five items; $\alpha = 0.86$; "Having an undesirable weight change would make me feel sad"), anger (four items; $\alpha = 0.93$; "Having an undesirable weight change would make me feel angry"), excitement (four items; $\alpha = 0.65$; "Having an undesirable weight change would make me feel excited"), and happiness (four items; $\alpha = 0.88$; "Having an undesirable weight change would make me feel happy"). The first three dimensions evaluated negative emotional reactions while the other two evaluated positive emotional reactions. All items were answered on a 5-point Likert scale (0 = not at all; 4 = extremely). Higher scores on each dimension indicate a greater emotional reaction.

*COPE inventory-reduced (COPE-R)* [28] This instrument was adapted from the early works of Carver et al. [26, 27]. This inventory evaluates possible coping strategies for a specific stressful situation (i.e., in our case, related to an undesirable weight change), and it has 16 items equally divided by its four subscales (each one characterizes a different coping strategy): active confrontation (four items; $\alpha = 0.78$; "I would try hard to solve the problem"), denial (four items; $\alpha = 0.60$; "I would not believe that the problem had happened"), humour (four items; $\alpha = 0.91$; "I would seek humour about the stress I would feel"), and emotional support (four items; $\alpha = 0.78$; "I would tell other people about my feelings"). All items were answered on a 5-point Likert scale (1 = used very little or not at all; 5 = used very much) with higher scores indicating greater utilization of the respective coping strategy. We added an item that evaluated the general levels of stress induced by the stressful event to confirm whether the situation was identified as a stressor by the athlete (for more information see the works of Giacobbi and Weinberg and Gomes et al. [36, 37]). This item was answered on a 4-point Likert scale (0 = low stress; 4 = high stress).

*Eating Disorder Examination Questionnaire (ED-15)* [38, 39] This 15-item instrument includes two dimensions: weight and shape concerns (six items; $\alpha = 0.86$, for this study) and eating concerns (four items; $\alpha = 0.64$, for this study). A global score ($\alpha = 0.83$, for this study) was also calculated from the average of the two subscales scores. The ED-15 includes five items assessing specific disordered behaviour related to eating in the last days before the competition (adapted for this study): objective binges, induced vomiting episodes (e.g., in the week before a competition, and considering an unwanted weight change, how many times did you vomit to control your body weight and shape?), laxative use days, food restriction days, and exercise days. All items were answered on a 7-point Likert scale (0 = nothing; 7 = always), and higher scores correspond to more disordered eating.

### Statistical analyses

IBM® SPSS® (Statistical Package for the Social Sciences) was used for data analysis. Descriptive statistics were used to characterize eating behaviours, stress related to a specific sports event, cognitive appraisal, coping strategies, and emotions. A multivariate analysis (two-way MANOVA) was performed to explore the role of different primary cognitive assessment patterns (higher threat/lower challenge) for the remaining study variables. Finally, to explain the disordered eating behaviour, we applied a linear regression analysis with a blocked entry procedure that controlled for personal variables (sex, awards, and weight desired), cognitive appraisal, coping and emotions.

## Results

### Descriptive values of psychological variables and eating behaviour

The disordered eating behaviour most reported by participants in the last week was dietary restraint ($n = 105$; 64.8%) followed by intense physical activity ($n = 103$, 63.6%). Participants also reported binge eating ($n = 28$, 17.3%), laxative misuse ($n = 14$, 8.6%), and induced vomiting ($n = 6$, 3.7%).

In regard to an undesirable change in weight one week before a competition, some participants reported no stress or not much stress ($n = 12$; 7.3%), others reported some stress ($n = 58$, 35.4%), but most participants reported very stress or very high stress ($n = 94$, 57.3%). Table 1 presents the descriptive statistics of disordered eating behaviours, cognitive appraisal, coping, and emotions.

**Table 1** Descriptive statistics of disordered eating behaviour, cognitive appraisal, coping, and emotions

| | *n* | M | SD | Min | Max |
|---|---|---|---|---|---|
| ED-15 | | | | | |
| Weight and shape concerns | 162 | 1.08 | 1.18 | 0 | 5 |
| Eating concerns | 163 | 2.84 | 1.39 | 0 | 6 |
| Total | 162 | 1.78 | 1.08 | 0 | 4.80 |
| PSCAS | | | | | |
| Importance perception | 166 | 5.43 | 0.82 | 2.33 | 6 |
| Threat perception | 165 | 3.50 | 1.60 | 0 | 6 |
| Challenge perception | 164 | 2.56 | 1.45 | 0 | 6 |
| COPE-R | | | | | |
| Active confrontation | 161 | 3.99 | 0.87 | 1 | 5 |
| Denial | 160 | 1.58 | .66 | 1 | 4 |
| Humour | 159 | 2.08 | 1.09 | 1 | 5 |
| Emotional support | 161 | 2.75 | 0.87 | 1 | 5 |
| SEQ | | | | | |
| Anxiety | 161 | 2.10 | 0.92 | 0 | 4 |
| Dejection | 161 | 1.67 | 1.02 | 0 | 4 |
| Anger | 160 | 1.68 | 1.26 | 0 | 4 |
| Excitement | 157 | 1.30 | 0.83 | 0 | 3.75 |
| Happiness | 161 | 0.41 | 0.78 | 0 | 4 |

*ED15* Eating Disorder Examination Questionnaire, *PSCAS* Primary and secondary Cognitive Appraisal Scales, *COPE-R* Coping Inventory, *SEQ* Sport Emotion Questionnaire

### Associations between the variables under study

Table 2 presents Pearson's correlations between the variables under study. It is possible to note that greater threat perception reported by athletes was associated with reporting more coping behaviours of active confrontation, more anxiety, dejection, and anger, and less coping with humour. Moreover, athletes perceiving the situation as more challenging reported more positive emotions such as excitement and happiness and fewer concerns about weight, shape, and disordered eating behaviours.

Furthermore, reports of more disordered eating behaviours were associated with more anxiety, dejection, anger, and a greater tendency to face a stressful situation with denial. Additionally, reporting more eating concerns was associated with using more active confrontation to deal with the stressful situation while reporting more eating concerns and more disordered eating behaviours were associated with using more emotional support to cope with the stressful situation.

### Differences in psychological factors and eating behaviour in relation to cognitive appraisal

This analysis included only participants that evaluated the stressful situation (unwanted weight change before a competition) as important using a cut-off equal to or higher than two points on the scale of the importance perception on the PSCAS instrument. This decision followed theoretical indications that only when a situation is perceived as important is it possible to feel threatened or challenged [25]; the cut-off followed indications of previous studies using this instrument [25, 40]. Thus, six athletes were removed from this analysis.

Table 3 introduces the multivariate analyses (two-way MANOVA) used to test for differences in psychological factors and eating behaviours in relation to cognitive appraisal patterns. As theoretically proposed by Lazarus [20, 21], this option allowed us to evaluate the interactive effects that can happen at the primary level on stress adaptation. The four comparison groups were formed from the median values obtained in the cognitive appraisal scores: low threat group

**Table 2** Correlations among variables under study

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | PSCAS threat | – | | | | | | | | | | | | | |
| 2 | PSCAS challenge | 0.10 | – | | | | | | | | | | | | |
| 3 | COPE-R active confrontation | 0.29*** | − 0.06 | – | | | | | | | | | | | |
| 4 | COPE-R denial | − 0.05 | 0.06 | − 0.15 | – | | | | | | | | | | |
| 5 | COPE-R humour | − 0.17* | 0.07 | − 0.14 | 0.35*** | – | | | | | | | | | |
| 6 | COPE-R emotional support | 0.21** | 0.12 | 0.21** | 0.29*** | 0.04 | – | | | | | | | | |
| 7 | SEQ anxiety | 0.63*** | 0.11 | 0.33*** | 0.06 | − 0.08 | 0.25*** | – | | | | | | | |
| 8 | SEQ dejection | 0.57*** | − 0.13 | 0.35*** | 0.08 | − 0.10 | 0.19* | 0.69*** | – | | | | | | |
| 9 | SEQ anger | 0.46*** | − 0.11 | 0.30*** | 0.11 | − 0.08 | 0.14 | 0.67*** | 0.88*** | – | | | | | |
| 10 | SEQ excitement | 0.09 | 0.48*** | − 0.03 | 0.17* | 0.11 | 0.08 | 0.09 | − 0.13 | − 0.02 | – | | | | |
| 11 | SEQ happiness | − 0.15 | 0.33*** | − 21** | 0.23** | 0.30*** | 0.04 | − 0.08 | − 0.24** | − 0.22** | 0.49*** | – | | | |
| 12 | ED15 weight and shape concerns | 0.08 | 0.18* | − 0.03 | 0.45*** | 0.13 | 0.15 | 0.33*** | 0.26*** | 0.27*** | 0.10 | 0.21** | – | | |
| 13 | ED15 eating preoccupation | 0.15 | 0.08 | 0.27*** | 0.17** | 0.13 | 0.19* | 0.35*** | 0.30*** | 0.31*** | 0.09 | 0.10 | 0.46*** | – | |
| 14 | ED15 total | 0.13 | 0.16* | 0.12 | 0.38*** | 0.15 | 0.19* | 0.40*** | 0.32*** | 0.33*** | 0.11 | 0.19* | 0.89*** | 0.82*** | – |

*PSCAS* Primary and Secondary Cognitive Appraisal Scale, *COPE-R* Coping Inventory, *SEQ* Sport Emotion Questionnaire, *ED15* Eating Disorder Examination Questionnaire

*$p < 0.05$; **$p < 0.01$; ***$p \leq 0.001$

($n = 76$), higher threat group ($n = 84$), low challenge group ($n = 77$), higher challenge group ($n = 83$).

Starting with the eating behaviours results, the multivariate test was not significant [Wilks' $\lambda = 0.987$, $F(2,155) = 1.145$, $p = 0.354$, $\eta^2 = 0.013$] and the interaction was also not significant. However, we should report one significant result related to the main effect of threat perception on the eating concerns dimension ($p = 0.018$): the group of athletes that perceived a higher threat also experienced more concerns about food.

In the emotional experience, the multivariate test was not significant [Wilks' $\lambda = 0.95$, $F(5,144) = 1.508$, $p = 0.191$, $\eta = 0.191$]. However, there was a significant result in the interaction of cognitive appraisal with the emotion of anxiety ($p = 0.011$). Group 3 of the athletes (high threat, low challenge) showed higher anxiety levels while group 1 of the athletes (low threat, low challenge) showed lower anxiety. Additionally, four main effects should be noted: the group of athletes that perceived a higher threat reported higher dejection ($p < 0.001$) and anger ($p < 0.001$). On the other hand, the group of athletes that perceived a higher challenge revealed more excitement ($p < 0.001$) and happiness ($p = 0.036$).

Finally, regarding the coping strategies used by athletes to deal with the unwanted weight change, multivariate tests were not significant [Wilks' $\lambda = 0.966$, $F(4,149) = 1,296$, $p = 0.274$, $\eta^2 = 0.034$]. Additionally, no significant results were found in the interaction of cognitive appraisal with any of the four dimensions. However, we should report two main effects for the threat group in the active confrontation ($p = 0.001$) and emotional support ($p = 0.008$) dimensions. In this case, athletes who perceived the situation as more threatening also reported greater use of active confrontation and emotional support.

## Predictors of disordered eating behaviours

Table 4 shows the results of a linear regression analysis used to identify predictors of disordered eating behaviour. In this case, we adopted a hierarchical blocked entry procedure with four blocks: personal variables, primary cognitive appraisal dimensions, coping dimensions, and emotional dimensions. This hierarchical structure followed the assumptions proposed by Lazarus in 1991 and Gomes in 2014 [20, 25] related to the adaptation process in a stressful situation.

In the first model, personal variables did not predict disordered eating behaviour. However, the variable weight desired was significant ($p = 0.022$). The second model was significant ($p = 0.031$), and the variable primary cognitive appraisal explained 5% of the disordered eating variance; in this case, threat perception related to changes in weight before a competition (stressful situation) was significant ($p = 0.027$). The third model was significant ($p < 0.001$), and the inclusion of coping variables led to a 24% explanation

**Table 3** Differences in variables under study in relation to cognitive appraisal patterns

| Variables | Group 1 Threat Challenge | Group 2 Threat Challenge | Group 3 Threat Challenge | Group 4 Threat Challenge | Threat | | | Challenge | | | Interaction 2X2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M (SD) | M (SD) | M (SD) | M (SD) | *df* | *F* | *p* | *df* | *F* | *p* | *df* | *F* | *p* |
| Eating disorders (ED-15) | | | | | | | | | | | | | |
| Weight and shape concerns | 0.94 (1.21) | 1.00 (1.07) | 0.89 (0.89) | 1.48 (1.43) | 1,16 | 1.41 | 0.237 | 1,16 | 3.16 | 0.077 | 1,16 | 2.10 | 0.149 |
| Eating concerns | 2.65 (1.62) | 2.44 (1.09) | 3.03 (1.51) | 3.11 (1.25) | 1,16 | 5.73 | 0.018 | 1,16 | 0.09 | 0.768 | 1,16 | 0.44 | 0.509 |
| Emotions (SEQ) | | | | | | | | | | | | | |
| Anxiety | 1.36 (0.86) | 1.78 (0.76) | 2.68 (0.89) | 2.44 (0.62) | 1,15 | 60.02 | 0.000 | 1,15 | 0.49 | 0.486 | 1,15 | 6.59 | 0.011 |
| Dejection | 1.24 (0.99) | 1.11 (0.85) | 2.35 (0.91) | 1.92 (0.81) | 1,15 | 43.86 | 0.000 | 1,15 | 3.69 | 0.057 | 1,15 | 1.13 | 0.289 |
| Anger | 1.20 (1.24) | 1.17 (1.17) | 2.37 (1.16) | 1.90 (1.08) | 1,15 | 25.56 | 0.000 | 1,15 | 1.75 | 0.188 | 1,15 | 1.35 | 0.247 |
| Excitement | 0.80 (0.73) | 1.58 (0.84) | 0.98 (0.55) | 1.60 (0.79) | 1,15 | 0.74 | 0.392 | 1,15 | 33.98 | 0.000 | 1,15 | 0.47 | 0.493 |
| Happiness | 0.32 (0.85) | 0.50 (0.72) | 0.15 (0.34) | 0.43 (0.79) | 1,15 | 1.13 | 0.289 | 1,15 | 4.50 | 0.036 | 1,15 | 0.20 | 0.655 |
| Coping (COPE-R) | | | | | | | | | | | | | |
| Active confrontation | 3.69 (1.10) | 3.80 (0.95) | 4.31 (0.72) | 4.11 (0.58) | 1,15 | 11.39 | 0.001 | 1,15 | 0.12 | 0.733 | 1,15 | 1.27 | 0.262 |
| Denial | 1.69 (0.77) | 1.53 (0.60) | 1.45 (0.46) | 1.70 (0.76) | 1,15 | 0.10 | 0.757 | 1,15 | 0.22 | 0.641 | 1,15 | 3.70 | 0.056 |
| Humour | 2.26 (1.06) | 2.24 (1.09) | 1.96 (1.11) | 1.90 (1.09) | 1,15 | 3.33 | 0.070 | 1,15 | 0.06 | 0.811 | 1,15 | 0.01 | 0.931 |
| Emotional support | 2.49 (0.85) | 2.63 (0.83) | 2.83 (0.87) | 3.02 (0.86) | 1,15 | 7.22 | 0.008 | 1,15 | 1.35 | 0.248 | 1,15 | 0.04 | 0.848 |

Significant results are underlined (interactive effects and main effects)

*ED-15* Eating Disorder Examination Questionnaire, *SEQ* Emotions in Sport Questionnaire; COPE-R Coping Inventory

of the variance in disordered eating behaviours; in this case, active confrontation ($p = 0.007$) and denial ($p < 0.001$) were significant. Finally, the inclusion of the fourth model related to emotions increased the explanation of disordered eating variance to 28%; in this case, anxiety was a significant variable ($p = 0.040$) in the explanation of disordered eating behaviours.

## Discussion

Athletes who practice combat sports with weight classes are at greater risk of engaging in disordered eating behaviours. Considering the available literature, it is possible to suggest that disordered eating behaviours may be influenced by the perception of stress, cognitive appraisal of the situation, posterior mechanisms of coping used to deal with the situation, and emotional final reactions. However, to the best of our knowledge, no previous studies have evaluated these variables together. Thus, the aim of this research was to simultaneously investigate eating behaviours, stress perception, cognitive appraisal, coping strategies, and emotions in combat sports athletes.

The first specific goal of this study was to characterize eating behaviour and stress perception in combat sports athletes. Consistent with previous studies [11, 12, 15–18], the athletes of our study reported a considerable engagement in disordered eating behaviours, such as dietary restraint, intense physical activity, binge eating episodes, laxative misuse, and induced vomiting. Previous research has systematically linked these behaviours with poor health outcomes [11, 12, 15, 17, 41]. However, it is also important to note that the engagement in weight loss strategies also plays important functions beyond weight reduction to gain a physical advantage over the opponent. Indeed, weight regulation helps to promote a sport identity and a feeling of focus, commitment and belonging (i.e., it is a cultural tradition in combat sports), and serves as a coping strategy to deal with stress [13].

Regarding stress perception, athletes answered the evaluation protocol thinking about the possibility of facing an undesirable change in weight before a competition. The results indicated that this hypothetical change in weight was perceived by most of the athletes as highly stressful. This evidence is in line with previous studies that stressed that the sports context is a promotor of specific stress [42–44]. In addition, higher levels of stress are linked with threat appraisal [45], negative emotions [46], dysfunctional coping strategies [47], and disordered eating behaviours such as binge eating and purging [48].

The second specific goal was to analyse differences in eating behaviours and psychological variables regarding primary cognitive appraisal patterns. The athletes that perceived a higher threat also experienced more eating concerns. This finding provides additional support for a previous study that found an association between threat perception and bulimic symptoms [24]. For emotions, the athletes who reported more threat perception had a greater tendency to

**Table 4** Regression model results for personal variables, cognitive appraisal, coping, and emotions explaining disordered eating behaviour

| | $R^2$ (adj $R^2$) | $F$ | $\beta$ | $\beta$ CI 95% | $t$ |
|---|---|---|---|---|---|
| Model 1: personal variables | 0.05 (0.03) | (3,144) 2.41 | | | |
| Sex[(a)] | | | – 0.02 | [– 0.44, 0.35] | – 0.21 |
| Awards[(b)] | | | – 0.12 | [– 0.64, 0.11] | – 1.40 |
| Weight desired[(c)] | | | – 0.19 | [– 0.75, – 0.06] | 2.31* |
| Model 2: PSCAS | 0.09 (0.05) | (5,142) 2.62* | | | |
| Threat perception | | | 0.18 | [– 0.76, – 0.07] | 2.23* |
| Challenge perception | | | 0.05 | [0.01, 0.23] | 0.59 |
| Model 3: COPE-R | 0.29 (0.24) | (9,138) 6.12*** | | | |
| Active confrontation | | | 0.21 | [0.07, 0.46] | 2.72** |
| Denial | | | 0.42 | [0.41, 0.93] | 5.05*** |
| Humour | | | 0.01 | [– 0.14, 0.16] | 0.17 |
| Emotional support | | | 0.04 | [– 0.15, 0.23] | 0.45 |
| Model 4: SEQ | 0.35 (0.28) | (14,133) 5.09*** | | | |
| Anxiety | | | 0.24 | [0.01, 0.53] | 2.09* |
| Dejection | | | 0.10 | [– 0.25, 0.44] | 0.56 |
| Anger | | | 0.06 | [– 0.21, 0.31] | 0.38 |
| Excitement | | | – 0.03 | [– 0.28, 0.21] | – 0.30 |
| Happiness | | | 0.01 | [– 0.27, 0.32] | 0.15 |

*PSCAS* Primary and Secondary Cognitive Appraisal Scale, *COPE-R* Coping Inventory, *SEQ* Sport Emotion Questionnaire, *ED15* Eating Disorder Examination Questionnaire

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

[(a)]Sex: 0 = male, 1 = female

[(b)]Awards: 0 = no awards; 1 = with awards

[(c)]Weight desired: 0 = less weight, 1 = equal or more weight

experience negative emotions such as anxiety, dejection, and anger. Conversely, athletes who experienced more challenge perception also experienced more positive emotions such as happiness and excitement. These findings are similar to previous studies that reported an association between threat perception with negative emotions and challenge perception with positive emotions [49–51]. Concerning coping strategies, perceiving the situation as more threatening was associated with greater use of active confrontation and emotional support. These results are partially supported by a study involving athletes of other modalities that found an association between threat appraisal and emotion-focused coping. However, contrary to this study, threat appraisal was inversely associated with problem-focused coping, such as active confrontation [52].

The final objective was to identify predictors of disordered eating behaviours. A desired lower weight, cognitive appraisal of the undesirable situation (i.e., threat perception), coping mechanisms (i.e., active confrontation and denial), and emotional state (i.e., anxiety) were significant variables in explaining disordered eating behaviours in combat sports athletes. These findings are in line with previous research that showed a link between the desire to weigh less, threat perception, denial, anxiety and more dysfunctional behaviours [14, 31, 53, 54]. In contrast to other studies that stressed that active confrontation is presented in the literature as an effective coping mechanism [55], in this study, active confrontation predicted disordered eating behaviours. Thus, actively solving one problem (e.g., unwanted weight change) in some circumstances does not guarantee positive outcomes. The weight-loss strategies can act as a coping strategy by focusing on maintaining self-discipline and in controlling weight and diet, helping to diminish the focus on stressors and anxiety [13].

The major strength of this study is its innovative contribution to understanding how an unwanted weight change before a competition can be related to disordered eating in combat sports athletes by considering multiple variables regarding stress adaptation, such as cognitive appraisal and emotions. Nevertheless, there are some limitations that should be stressed, including the use of self-report measures that could induce social desirability, and a cross-sectional design that did not allow causality inferences from the current results. Additionally, the use of a convenience sample that may not be representative of the population that practises combat sports also calls for caution in the interpretation of the results. Finally, in the same line, this sample was mostly comprised of male adults, which did not allow for further interpretations about the role of sex and age differences in the present findings. Future studies

should attempt to study these variables with a more representative sample and with longitudinal methodologies.

### What is already known?

The available literature pointed out that combat sports athletes with weight classes are at greater risk of engaging in disordered eating behaviours. Previous study findings suggested that disordered eating behaviours may be influenced by stress, cognitive appraisal, coping, and emotions.

### What this study adds?

This study provides an innovative contribution to the understanding of how disordered eating in combat sports athletes can be related to psychological variables by adopting a closer approach using Lazarus' Transactional Model. In sum, the findings highlighted the role of human adaptation to stress in the comprehension of eating behaviour in combat sports athletes. Accordingly, to prevent or reduce disordered eating behaviours, it may be important to promote more positive interpretations of stressful situations (i.e., challenge perceptions to the detriment of threat perception), and positive emotions among sport combat athletes.

**Author contributions** All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by SG, AR and ARG. The first draft of the manuscript was written by SF and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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### Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflicts of interest.

**Ethics approval** This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of the University of Minho—Subcommission of the Social and Human Sciences (SECSH 043/2016).

**Informed consent** All participants in the study signed a written informed consent form.

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