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Eating disorder symptom dimensions and protective factors: A structural network analysis study

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ABSTRACT

Eating Disorders (EDs) and related symptoms pose a substantial public health concern due to their widespread prevalence among both genders and associated negative outcomes, underscoring the need for effective preventive interventions. In this context, deepening our understanding of the interplay between ED symptoms and related protective factors appears crucial. Therefore, this study employed a structural network analysis approach considering both ED symptom dimensions (i.e., drive for thinness, bulimic symptoms, and body dissatisfaction) and related protective factors (i.e., body and functionality appreciation, intuitive eating, and self-esteem) to shed light on how these factors are interrelated. A community sample of 1391 individuals (34.4% men; M_{age} = 26.4 years) completed a socio-demographic schedule and self-report questionnaires. The network showed that the nodes with the highest positive expected influence were body and functionality appreciation, while those with the highest negative expected influence were eating for physical rather than emotional reasons and unconditional permission to eat (i.e., two components of intuitive eating). Crucially, the most relevant bridges between the conceptual communities "ED symptom dimensions" and "Protective factors" were the negative relations between (a) eating for physical rather than emotional reasons and bulimic symptoms, (b) unconditional permission to eat and drive for thinness, and (c) body appreciation and body dissatisfaction. Finally, age, gender, and body mass index did not moderate any edge in the network. The practical implications of these findings are discussed, especially in terms of preventive interventions for ED symptoms.

1. Introduction

Eating Disorders (EDs) are severe psychological disorders that have rapidly increased during the last decade (Galmiche, Déchelotte, Lambert, & Tavolacci, 2019), particularly throughout the COVID-19 pandemic (Cooper et al., 2022; Linardon, Messer, et al., 2022). EDs and related symptoms are highly prevalent (Qian et al., 2021), supporting the idea that a moderate degree of ED symptoms is now normative among women (Wade, Wilksch, & Lee, 2012). At the same time, EDs symptoms have also been described among men (Silén & Keski-Rahkonen, 2022; Sparti, Santomauro, Cruwys, Burgess, & Harris, 2019); however, some differences exist in the cognitive processes and behavioral patterns exhibited by men and women (Cunningham, Nagata, & Murray, 2021). In particular, a pivotal gender-based distinction is that men often pursue a physique distinguished by lean and well-developed musculature, in contrast to the predominantly thin body standard preferred by women (Murray, Griffiths, & Mond, 2016, 2017). In the quest for the lean muscular body ideal, men tend to engage in various maladaptive eating and related behaviors, including compulsive exercise, excess calorie and macronutrients intake, extreme calorie restriction, binge-purge behaviors, and the use of muscle-enhancing substances (Lavender, Brown, & Murray, 2017). Notably, men have been found to show a comparable severity of ED symptoms (i.e., disordered eating and compulsive exercise) to women (Mitchison, Mond, Slewa-Younan, & Hay, 2013; Striegel, Bedrosian, Wang, & Schwartz, 2012), highlighting the importance of recognizing and addressing these problems in both genders. Full-blown EDs, as well as their subclinical forms, are characterized by chronicity and have serious consequences, including deleterious outcomes in terms of physical and mental health (Kärkkäinen, Mustelin, Raevuori, Kaprio, & Keski-Rahkonen, 2018; Keski-Rahkonen & Mustelin, 2016) and reduced quality of life (Mitchison, Hay, Slewa-Younan, & Mond, 2012).

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Given the high prevalence and the burden associated to EDs and related symptoms (Hay et al., 2023; Santomauro et al., 2021), psychological interventions aimed to prevent the development of EDs and related symptoms are urgently needed (Grange & Loeb, 2007); this gains even more relevance when considering the transgenerational transmission of the risk for these psychopathologies and associated behaviors (Cimino et al., 2018; Maremmani et al., 2017).

To be effective, preventive interventions should encompass both a disease reduction perspective (i.e., reducing risk factors) and a health promotion perspective (i.e., maximizing protective factors; Levine & Smolak, 2016; Piran, 2015; Sundgot-Borgen et al., 2018). However, in the last decades, efforts to prevent the development of EDs and related symptoms have primarily focused on the former approach, such as by reducing body dissatisfaction, while providing less attention to fostering positive psychological functioning (Linardon, Tylka, Burnette, Shatte, & Fuller-Tyszkiewicz, 2022). This one-sided approach has resulted in limited success in preventing EDs.

Over the past 15 years, several protective factors have been proposed to mitigate the development of EDs and related symptoms (Tylka, 2019). Among these, positive body image (e.g., Alleva, Paraskeva, Craddock, Stuijfzand, & Diedrichs, 2022; Linardon, 2021; Linardon, McClure, Tylka, & Fuller-Tyszkiewicz, 2022), self-esteem (e.g., Svantorp-Tveiten et al., 2021; Voica, Kling, Frisen, & Piran, 2021), and intuitive eating (e.g., Hazzard et al., 2021; Linardon, 2021) have emerged as the most effective to date, and represent key targets for preventive interventions (Piran, 2015; Tylka, 2019).

1.1. Theoretical framework

Our study is grounded in the framework of positive psychology (Seligman & Csikszentmihalyi, 2000), which emphasizes the exploration of individuals' strengths and resilience, integrating these elements for both prevention and treatment purposes. Specifically, within the context of EDs, we adopted the Embodied Self Model (previously known as the Attuned Representational Model of Self; Cook-Cottone, 2006) as a guiding framework. The Embodied Self Model provides a comprehensive framework supporting self-esteem, positive body image, and intuitive eating as protective factors for EDs and related symptoms. According to this model, central to ED symptoms is the relation that an individual has with his/her body, reflected in how the body is experienced, fed, cared for, and accepted. Pivotal to the model is also the loss of an embodied sense of self (Cook-Cottone, 2015), which leads to misattunement and a disconnection with body signals. The model offers strategies to reconnect with oneself, promoting self-loving kindness, appreciation of the body and its functionality, and intuitive eating practices. Cultivating a positive body image and intuitive eating practices, according to this model, represent salutogenic approaches believed to help individuals with disordered eating nurture a healthier relationship with their bodies, ultimately reducing disordered behaviors and body dissatisfaction.

1.2. Protective factors for EDs and related symptoms: self-esteem, positive body image, and intuitive eating

Self-esteem – an individual's overall sense of self-worth or personal value (Rosenberg, 1965) – has been extensively studied in relation to EDs symptom (Linardon, Kothe, & Fuller-Tyszkiewicz, 2019; Stice, 2002). Low self-esteem has been identified as a significant predictor and a powerful factor in perpetuating all forms of EDs in both women and men (Schmidt & Treasure, 2006), and these results apply also in non-clinical samples (Brechan & Kvalem, 2015; Fernandez & Pritchard, 2012). A recent meta-analysis of longitudinal studies (Krauss, Dapp, & Orth, 2023) confirmed that self-esteem negatively predicted eating pathology over time in 48 independent samples (including data from more than 19,000 participants), suggesting that low self-esteem makes people more vulnerable to developing EDs and speculating that improving self-esteem may be useful for reducing the risk for these disorders in the first place. Based on these premises, a few studies have been conducted to investigate the protective role of self-esteem on EDs and related symptoms, demonstrating that self-esteem might protect against developing ED symptoms in both women and men (Brechan & Kvalem, 2015; Croll, Neumark-Sztainer, Story, & Ireland, 2002; Voica et al., 2021). Finally, in a review of existing preventive interventions that aimed to enhance self-esteem, O'Dea (2004) determined that programs incorporating elements to bolster self-esteem have led to improvements in maladaptive eating.

Linked to self-esteem, a second relevant protective factor for EDs is positive body image (Alleva, Tylka, & Kroon Van Diest, 2017). Positive body image - an overall love and respect for one's body - is a multifaceted construct different from negative body image (Tylka & Wood-Barcalow, 2015a) and occurs when individuals accept, appreciate, and respect their body despite its flaws. Positive body image is associated with multiple aspects of well-being (e.g., self-esteem, optimism, and life satisfaction; Halliwell, 2015; Tylka & Wood-Barcalow, 2015b) and protects against the development of psychological disorders, including EDs (Tylka & Wood-Barcalow, 2015b). Among its facets, positive body image includes body appreciation and body functionality appreciation. Body appreciation is one of the most widely researched dimensions of positive body image, defined as "accepting, holding favorable attitudes toward, and respecting the body, while also rejecting media-promoted appearance ideals as the only form of beauty" (Tylka & Wood-Barcalow, 2015b, p. 53). Body appreciation is a core component of positive body image, and recent studies found that it protects against the onset of ED symptoms (e.g., Linardon, 2021; Linardon, McClure, et al., 2022). Body functionality appreciation, on the other side, refers to appreciating, respecting, and honoring the body for what it can do, including physical capacities, functions related to internal processes, body sensations and communication, creative endeavors, as well as self-care (Alleva, Martijn, Van Breukelen, Jansen, & Karos, 2015; Alleva et al., 2017).

Recent studies have demonstrated that both body and functionality appreciation may serve as protective factors against EDs and related symptoms. For instance, Linardon (2021) conducted a prospective study involving 1270 women who completed questionnaires investigating seven core ED symptoms and putative protective factors at baseline (T0) and eight months later (T1). The findings from both univariate and multivariate analyses revealed that positive body image, as well as intuitive eating, predicted a lower likelihood of experiencing the onset of various ED symptoms. Moreover, their greater increase over time was associated with lower odds of ED symptom onset. Similarly, a study by Messer, Tylka, Fuller-Tyszkiewicz, and Linardon (2022) showed that body appreciation was significantly associated with a lower likelihood of engaging in ED symptoms (e.g., binge eating, dietary restriction, and fasting) over an eight-month period in a sample of women. Furthermore, two recent meta-analyses provided additional support for these findings, demonstrating an inverse association between body and functionality appreciation and ED symptoms, as well as body image disturbances (Linardon, McClure, Tylka, & Fuller-Tyszkiewicz, 2022; Linardon, Messer, & Tylka, 2023).

A third established protective factor for EDs is intuitive eating, an adaptive eating style guided by attunement to one's bodily cues (e.g., hunger, satiety) rather than by emotional or external cues (e.g., sadness, dietary rules) to determine what, when, and how much to eat (Tylka, 2006). Intuitive eating is characterized by four dimensions (Tylka & Kroon Van Diest, 2013), namely unconditional permission to eat, eating for physical rather than emotional reasons, reliance on hunger and satiety cues, and body-food choice congruence. Intuitive eating and related dimensions emerged as associated with lower EDs symptoms in different contexts and populations (see Bruce & Ricciardelli, 2016 for a systematic review; see Linardon, Tylka, & Fuller-Tyszkiewicz, 2021 for a meta-analysis).

Concerning the general construct of intuitive eating, Linardon

(2021) found that intuitive eating hinders the onset of specific ED symptoms (e.g., subjective and objective binge eating, purging, and driven exercise). These findings were consistent with other studies and meta-analyses. A longitudinal research by Hazzard et al. (2021) revealed that higher levels of intuitive eating at baseline and subsequent changes were associated with reduced body dissatisfaction and unhealthy weight control behaviors over an eight-year period. Similarly, Christoph et al. (2021) revealed that intuitive eating was associated with reduced prevalence of dieting, unhealthy weight control behaviors, and binge eating five years later. Finally, a recent meta-analysis reported robust cross-sectional associations between intuitive eating and lower levels of disordered and restrictive eating, and body image concerns (Linardon et al., 2021). Concerning specific intuitive eating dimensions, a recent study by Messer et al. (2022) found that only the unconditional permission to eat represented an intermediate mechanism among body appreciation and ED symptoms, while the other dimensions did not. Collectively, these findings highlight the protective role of intuitive eating in preventing and reducing ED symptoms across diverse timeframes.

Results of the above-mentioned studies are crucial, since they suggest that positive body image, self-esteem, and intuitive eating may represent protective factors against EDs symptoms.

1.3. The current study

Based on the principles of positive psychology and the lens of the Embodied Self Model, the present study aimed to expand previous research on protective factors for EDs with a structural network analysis design, allowing us to examine the interplay between ED symptom dimensions and related protective factors. Unlike traditional approaches (i.e., structural equation modeling), network analysis is a data-oriented technique devoid of the necessity for hypotheses. Consequently, this approach holds potential in enhancing comprehension of the interrelationships among factors, often revealing insights not initially anticipated by researchers. Moreover, network analysis enables the identification of central nodes that are likely to be the most influential nodes within symptom networks (Borsboom & Cramer, 2013; McNally, 2016), while also allowing for identification of bridge edges, which link two distinct clusters (e.g., ED symptom dimensions and protective factors). In line with the network analysis theory, focusing on bridge pathways could potentially interrupt the edges within symptom networks, leading to a decrease in symptom severity over time. This may be particularly relevant for the development of effective preventive interventions for EDs, specifically focused on protective factors.

While several studies have been conducted by applying a network analysis approach in the field of EDs (e.g., DuBois, Rodgers, Fuller-Tyszkiewicz, Shiyko, & Franko, 2023; Forbush, Siew, & Vitevitch, 2016; Rodgers, DuBois, Frumkin, & Robinaugh, 2018; Smith et al., 2018), no previous study has yet included positive body image, self-esteem, and intuitive eating when forming a network structure considering ED symptoms, despite few studies have considered other specific protective factors in relation to EDs (i.e., Brown et al., 2020; Sala, Vanzhula, Roos, & Levinson, 2022). Furthermore, most of these studies have been conducted on women, oftentimes excluding men, with the exception of few studies that investigated ED symptoms among men (Forrest, Perkins, Lavender, & Smith, 2019; Perko, Forbush, Siew, & Tregarthen, 2019; Wang, Jones, Dreier, Elliott, & Grilo, 2019). However, the inclusion of men in research investigating protective factors for EDs is worthy of note, since rates of ED symptoms are rapidly increasing among men (Mitchison, Hay, Slewa-Younan, & Mond, 2014).

In conclusion, in our study, we aimed to strengthen previous findings by examining the interplay between protective factors (i.e., positive body image, self-esteem, and intuitive eating) for EDs and three ED symptom dimensions (i.e., drive for thinness, body dissatisfaction, and bulimic symptoms) using a structural network analysis approach in a mixed-gender sample. We also investigated the role played by relevant possible moderators of the relation among ED symptom dimensions and related protective factors (i.e., age, sex, and body mass index [BMI]; Nagata et al., 2019; Rohde, Stice, Shaw, Gau, & Ohls, 2017; Striegel-Moore & Bulik, 2007).

2. Method

2.1. Participants

The sample consisted of 1391 individuals (sex/gender[1] = 34.4% men; age = 26.4 ± 7.8 years, range 18–71 years; education = 15.9 ± 2.5 years, range 4–26 years; BMI = 22.8 ± 4.4, range 15–58) from different areas of Italy. The relationship and occupation status were diverse (73.3% single or engaged, 23.9% married or cohabiting, 2.7% separated or divorced, 1% widow/widower; 56.4% student, 18.6% full-time job, 5.5% unemployed, 5.4% fixed-term contract, 3.7% part-time, 10.4% other).

2.2. Measures

Participants completed a sociodemographic schedule that collected personal information (i.e., sex, gender, age, years of education, weight and height to compute the BMI, occupation and marital status) and anamnestic information (i.e., self-reported current or former psychological disorders, presence of physical disorders, and use of medications). Furthermore, participants completed self-report questionnaires investigating ED symptom dimensions and related protective factors. The selection of the measures was based on two criteria, namely good psychometric properties and availability in the Italian context.

The *Body Appreciation Scale-2* (BAS-2; Tylka & Wood-Barcalow, 2015b; Italian translation: Casale, Prostamo, Giovannetti, & Fioravanti, 2021) is a 10-item self-report questionnaire which assesses acceptance, love, and respect for one's body. All items are rated on a 5-point scale ranging from 1 (*never*) to 5 (*always*). Higher scores indicate higher levels of body appreciation. The Italian version of the BAS-2 showed a unidimensional factor structure, an adequate internal consistency (women: Cronbach's α = 0.93, McDonald's ω = 0.93; men: Cronbach's α = 0.89, McDonald's ω = 0.89), and good indices of validity in women and men (Casale et al., 2021). In the current study, McDonald's ω for the BAS-2 was 0.95 (95% CI = 0.95, 0.95) in women and 0.94 (95% CI = 0.93, 0.95) in men.

The *Functionality Appreciation Scale* (FAS; Alleva et al., 2017; Italian translation: Cerea, Todd, Ghisi, Mancin, & Swami, 2021) assessed appreciation and respect for body functionalities. The FAS comprises 7 items, that participants rate using a 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Higher scores indicate greater body functionality appreciation. The Italian version of the FAS provided the same factorial structure, an adequate internal consistency (women: McDonald's ω = 0.89; men: McDonald's ω = 0.90), good 3-week test-retest reliability, and good construct validity in women and men (Cerea et al., 2021). In the current study, McDonald's ω for the FAS was 0.90 (95% CI = 0.89, 0.91) in women and 0.89 (95% CI = 0.88, 0.91) in men.

The *Intuitive Eating Scale – 2* (IES-2; Tylka & Kroon Van Diest, 2013; Italian translation: Swami et al., 2021) is a self-report questionnaire assessing a person's intuitive eating behavior. The IES-2 enables to compute a total score and four subscales: *Unconditional Permission to Eat, UPE* (i.e., tendency to eat in response to internal cues related to hunger and satiety), *Eating for Physical Rather than Emotional Reasons, EPR* (i.e., tendency to eat in order to satisfy hunger and not to cope with momentary emotions or distress), *Reliance on Hunger and Satiety Cues, RHSC* (i.e., awareness of internal signals related to hunger and satiety, trust and reliance on them), and *Body-Food Choice Congruence, B-FCC* (i.

[1] Sex and gender align for all participants of the study.

e., tendency to listen to food that one's body needs and to eat nutritious food). All items were rated on a 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Higher scores indicate higher levels of intuitive eating and its dimensions. The factorial structure, convergent validity, and test-retest reliability were adequate in the Italian version (Swami et al., 2021). In the current study, the total score (women: McDonald's ω = 0.90; 95% CI = 0.90, 0.91; men: McDonald's ω = 0.86; 95% CI = 0.84, 0.88), the *UPE* subscale (women: McDonald's ω = 0.82; 95% CI = 0.81, 0.84; men: McDonald's ω = 0.78; 95% CI = 0.75, 0.81), the *EPR* subscale (women: McDonald's ω = 0.91; 95% CI = 0.90, 0.92; men: McDonald's ω = 0.89; 95% CI = 0.88, 0.91), the *RHSC* subscale (women: McDonald's ω = 0.92; 95% CI = 0.91, 0.92; men: McDonald's ω = 0.91; 95% CI = 0.89, 0.92), and the *B-FCC* subscale (women: McDonald's ω = 0.88; 95% CI = 0.86, 0.89; men: McDonald's ω = 0.84; 95% CI = 0.81, 0.86) showed adequate internal consistency.

The *Rosenberg Self-Esteem Scale* (RSES; Rosenberg, 1965; Italian translation: Prezza, Trombaccia, & Armento, 1997) is a 10-item self-report questionnaire assessing self-esteem on a 4-point Likert scale, ranging from 1 (*strongly disagree*) to 4 (*strongly agree*). Higher scores represent greater self-esteem. Scores on the Italian version of the RSES showed good internal consistency and adequate construct validity (Cronbach's α = 0.84; Prezza et al., 1997). In the current study, McDonald's ω for the RSES was 0.91 (95% CI = 0.90, 0.92) in women and 0.90 (95% CI = 0.88, 0.91) in men.

The three subscales *Drive for Thinness* (DT; 7 items), *Bulimia* (B; 7 items), and *Body Dissatisfaction* (BD; 9 items) of the *Eating Disorder Inventory-3* (EDI-3; Garner, 2004; Italian translation: Giannini, Pannocchia, Dalle Grave, Muratori, & Viglione, 2008) were used to assess dysfunctional eating behaviors and body dissatisfaction. Overall, the EDI-3 is a self-report questionnaire assessing psychological features and behaviors associated with disordered eating, utilizing a 6-point scale, ranging from 1 (*never*) to 6 (*always*). Higher scores indicate greater dysfunctional eating and body dissatisfaction. The Italian version of the EDI-3 showed good internal consistency in a clinical sample (Cronbach's αs ranging from 0.70 to 0.94) and in a non-clinical sample (Cronbach's αs ranging from 0.70 to 0.92, except for the Asceticism subscale: Cronbach's α = 0.55; Giannini et al., 2008). In the current study, scores at the DT subscale (women: McDonald's ω = 0.92; 95% CI = 0.91, 0.93; men: McDonald's ω = 0.88; 95% CI = 0.86, 0.89), the B subscale (women: McDonald's ω = 0.89; 95% CI = 0.88, 0.90; men: McDonald's ω = 0.84; 95% CI = 0.81, 0.86), and the BD subscale (women: McDonald's ω = 0.88; 95% CI = 0.87, 0.89; men: McDonald's ω = 0.87; 95% CI = 0.85, 0.89) showed adequate internal consistency.

2.3. Procedure

Participants were recruited via advertisements shared on social media platforms (i.e., Instagram, Facebook), supplemented with a snowball sampling method. Inclusion criteria were being an Italian native speaker and at least 18 years old. Before filling in the above-mentioned measures, participants were provided with an online informed consent including information about the purposes of the study, the voluntary nature of the participation, and the possibility to withdraw from the study without penalty. Thus, participants took part on a voluntary basis and without reimbursement. To guarantee the privacy of each participant, a personal code was required, consisting of the first letters of their name and surname followed by their date of birth. To ensure that no participant completed the survey more than once, we examined personal codes provided by participants, as well Internet Protocol (IP) addresses. Furthermore, to ensure accurate responding, three catch items ("Please select the option 'Strongly Agree' for this question to indicate that you are paying attention") were randomly added along the survey to evaluate participants' engagement and identify inattentive responding. Participants who selected an option other than "Strongly Agree" in any or all of the catch items ($n = 15$) were excluded from any further analysis. The time it took participants to complete the survey was also measured; participants who completed the survey in less than 12 min ($n = 5$) were excluded from any further analysis.

The study was conducted in accordance with the Declaration of Helsinki and ethics approval was obtained from the relevant departmental ethics committee at the School of Psychology, University of Padova (approval code: 2871BB770B52DDDABE6903EFFD81C9C7).

2.4. Statistical analysis

The analytical procedure followed the following steps. First, we explored means, standard deviations, and Pearson's correlations of the variables considered in this study. Then, we followed the procedure described by Jones (2018), in order to evaluate the degree of redundancy among each pair of nodes. Two nodes were considered redundant if they shared less than 25% statistically different correlations with the other nodes of network. Second, an EBIC graphical LASSO network was estimated, with blue and red edges indicating positive and negative associations, respectively. Importantly, in the context of LASSO network estimation, each edge is to be deemed as locally independent (i.e., non-spurious) with regards to the other nodes of the network (Epskamp & Fried, 2018). Inferences on the network structure were derived by means of two metrics, namely one-step expected influence and predictability. One-step expected influence (henceforth expected influence) refers to the sum of all edges extending from a given node, but, unlike the more frequently used strength index, the sign of each edge is maintained (Robinaugh, Millner, & McNally, 2016). This metric is usually adopted when both positive and negative edges are present in the network. High levels of positive or negative expected influence (i.e., farther away from the zero) indicate nodes that may potentially play an "activating" or "deactivating" influence on the network, respectively. Expected influence levels closer to zero suggest no influence. It is crucial to emphasize that this metric alone cannot suggest any direct causal influence, as this must be determined through controlled experimental manipulations. Predictability provides information as to how much variance of a node could be explained by all the nodes connected to it (Haslbeck & Waldorp, 2018). Third, bootstrapping resampling was used to determine the precision and stability of the estimates (i.e., edges and expected influence) (Epskamp & Fried, 2018). While narrow 1000-bootstrap 95% non-parametric confidence intervals (CIs) indicate precise estimates, correlation stability coefficient (i.e., *CS-coefficient*) values above 0.25, but preferentially above 0.5, suggest stable estimations. Comparisons of expected influence indices and edges similarly relied on bootstrap CIs. Fourth, 10-fold cross-validation was used to approximate the degree to which the estimated LASSO network could generalize to new data and replicate in future studies. In detail, the association between nodes was estimated as "deviance explained" (R^2_D), namely the ratio of Kullback–Leibler divergence between fitted and null models (Cameron & Windmeijer, 1997). After dividing the sample into 10 folds, each edge was computed on 9 folds and then predictive R^2_D was estimated on the remaining tenth fold. This procedure was serially conducted across all the folds and then repeated 10 times. Finally, partialization and LASSO regularization was applied on the final matrix of predictive values of deviance explained (for a detailed description of the method, see Marchetti, 2023). Minor differences between the original and the cross-validated networks indicate high likelihood of replicability of the findings. Fifth, after identifying two theory-based communities (i.e., "ED symptom dimensions" and "Protective factors"), the links between the two clusters were investigated with bridge expected influence. This index quantifies the expected influence (see above) of a node belonging to community "ED symptom dimensions" with all nodes of community "Protective factors" (Jones, Ma, & McNally, 2021). Sixth, moderated network analysis with both continuous and categorical data was performed, as outlined by Haslbeck, Borsboom, and Waldorp (2021). No missing data emerged; participants were prompt in responding to all items.

3. Results

3.1. Descriptive statistics

In Table 1, we reported means, standard deviations, and Pearson's correlations for the whole sample. Gender-split descriptive statistics are shown in Table S1 (Supplementary Materials).

3.2. Network estimation, inference, stability, and cross-validation

Preliminarily, we conducted a redundancy analysis, which showed that there were no overlapping nodes in the network (i.e., less than 25% statistically different correlations; Jones, 2018). In other words, each node could be considered as linked in a substantially different way to all the other nodes in the network.

The network, consisting of both ED-related symptoms and protective factors, is shown in Fig. 1. Several points are noteworthy. First, functionality appreciation (FAS) and self-esteem (RSES) were positively correlated with body appreciation (BAS-2), which in turn was negatively associated with body dissatisfaction (BD). Second, the intuitive eating dimensions reliance on hunger and satiety cues (RHSC) and body-food choice congruence (B-FCC) were positively associated but were related with unconditional permission to eat (UPE) in opposite direction. In fact, this latter node was positively linked with reliance on hunger and satiety cues (RHSC) and negatively associated with body-food choice congruence (B-FCC) and drive for thinness (DT). Third, eating for physical rather than emotional reasons (EPR) and bulimic symptoms (B) were negatively correlated. Fourth, all the ED-related nodes were positively linked, although the association between bulimic symptoms (B) and body dissatisfaction (BD) was largely mediated by drive for thinness (DT).

The analysis revealed that the network was well-defined, in that the majority of the edges (i.e., 53.7%) were statistically different from one another (Fig. S1; Supplementary Materials). The four most strongly and positively associated nodes were body appreciation (BAS-2)/functionality appreciation (FAS), self-esteem (RSES)/body appreciation (BAS-2), reliance on hunger and satiety cues (RHSC)/body-food choice congruence (B-FCC), and drive for thinness (DT)/body dissatisfaction (BD). Interestingly, there were also four negative and strongly significant edges, which were statistically different from all the other edges, namely bulimic symptoms (B)/eating for physical rather than emotional reasons (EPR), drive for thinness (DT)/unconditional permission to eat (UPE), body dissatisfaction (BD)/body appreciation (BAS-2), and unconditional permission to eat (UPE)/body-food choice congruence (B-FCC) (see below).

Considering the presence of both positive and negative edges, we relied on expected influence to identify the most influential nodes (Fig. S2; Supplementary Materials), either in the positive or negative direction (i.e., stronger values are those that are farther away from zero; Eadeh, Adamowicz, Markon, & Thomas, 2023). On the one hand, the two nodes with highest positive expected influence in the whole network were functionality appreciation (FAS) and body appreciation (BAS-2), which were largely related to each other. On the other hand, eating for physical rather than emotional reasons (EPR) and unconditional permission to eat (UPE) were the nodes with highest negative expected influence. Moreover, body dissatisfaction (BD) and drive for thinness (DT) had almost null expected influence (i.e., when considering the sign, the sum of all edges approximated zero). It is worth stressing the estimation of the metric was very well-defined, in that the vast majority of the nodes (91.1%) were statistically different from each other (Fig. S3; Supplementary Materials).

Overall, the network was estimated in a very precise and reliable way (Fig. S4; Supplementary Materials). In particular, both edges and expected influence values were characterized by excellent levels of stability (CS-coefficient = 0.75 for both indices). Furthermore, predictability analysis revealed that, on average, 55% of variance of

Table 1
Means, standard deviations, and correlations.

Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12
1. *DT*: Drive for Thinness (EDI-3)	8.48	7.75												
2. *B*: Bulimia (EDI-3)	4.92	5.89	0.55**											
3. *BD*: Body Dissatisfation (EDI-3)	13.67	9.58	0.68**	0.53**										
4. *RSES*: Self-Esteem (RSES)	28.89	6.60	−0.32**	−0.34**	−0.40**									
5. *BAS-2*: Body Appreciation (BAS-2)	3.45	0.90	−0.51**	−0.45**	−0.67**	0.67**								
6. *FAS*: Functionality Appreciation (FAS)	4.08	0.75	−0.32**	−0.32**	−0.45**	0.51**	0.71**							
7. *UPE*: Unconditional Permission to Eat (IES-2)	3.64	0.91	−0.59**	−0.16**	−0.32**	0.14**	0.24**	0.17**						
8. *EPR*: Eating for Physical rather than Emotional Reasons (IES-2)	3.37	1.05	−0.43**	−0.69**	−0.50**	0.32**	0.42**	0.26**	0.10**					
9. *RHSC*: Reliance on Hunger and Satiety Cues (IES-2)	3.50	1.01	−0.50**	−0.53**	−0.54**	0.32**	0.52**	0.42**	0.30**	0.51**				
10. *B-FCC*: Body Food Choice Congruence (IES-2)	3.67	0.95	−0.18**	−0.35**	−0.34**	0.26**	0.45**	0.42**	−0.14**	0.34**	0.45**			
11. Age	26.38	7.84	−0.03	−0.09**	−0.04	0.17**	0.10**	0.04	−0.12**	0.09**	0.05	−0.01		
12. Body Mass Index	22.82	4.37	0.22**	0.30**	0.35**	−0.04	−0.18**	−0.15**	−0.08**	−0.24**	−0.25**	−0.19**	0.28**	
13. Gender	1.66	0.48	0.25**	0.11**	0.28**	−0.06*	−0.10**	−0.01	−0.11**	−0.23**	−0.13**	−0.02	−0.08**	−0.18**

Note: * indicates $p < 0.05$. ** indicates $p < 0.01$. Gender: man is the reference category.

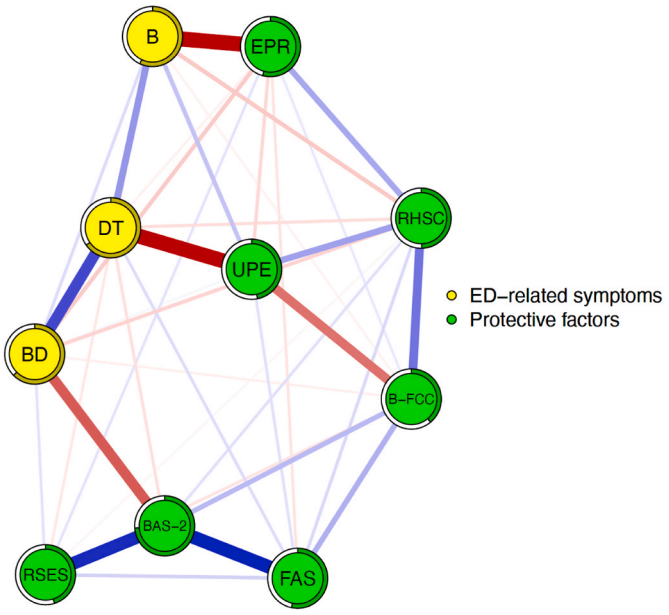

Fig. 1. Network model including ED symptom dimensions and protective factors.
Note: ED = Eating Disorder; DT = Drive for Thinness; B = Bulimia; BD = Body Dissatisfaction; BAS-2 = Body Appreciation Scale-2; FAS = Functionality Appreciation Scale; UPE = Unconditional Permission to Eat; EPR = Eating for Physical Rather than Emotional Reasons; RHSC = Reliance on Hunger and Satiety Cues; B-FCC = Body-Food Choice Congruence; RSES = Rosenberg Self-Esteem Scale.

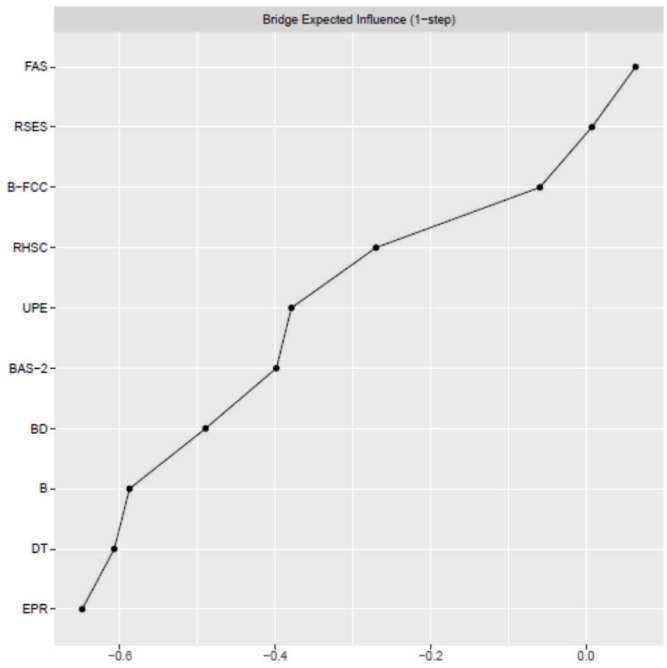

Fig. 2. Bridge expected influence values between ED symptom dimensions and protective factors communities.
Note: DT = Drive for Thinness; B = Bulimia; BD = Body Dissatisfaction; BAS-2 = Body Appreciation Scale-2; FAS = Functionality Appreciation Scale; UPE = Unconditional Permission to Eat; EPR = Eating for Physical Rather than Emotional Reasons; RHSC = Reliance on Hunger and Satiety Cues; B-FCC = Body-Food Choice Congruence; RSES = Rosenberg Self-Esteem Scale.

each node could be accounted for by the surrounding nodes, with predictability ranging from 39% for body appreciation (BAS-2) to 74% for body-food choice congruence (B-FCC).

Finally, the estimated network and the cross-validated predictive network were very similar (Figs. S5–S6; Supplementary Materials; centrality index $r_s = 0.64$). One notable exception was the negative relation between unconditional permission to eat (UPE) and body-food choice congruence (B-FCC), which was of moderate magnitude in the estimated network, but it was shrunk to zero in the cross-validated network. Consequently, any comment on the relation between these two nodes should be done with caution, in that this link is likely due to sample variability. Overall, the analysis indicated that the main findings of this study could likely generalize to new data and replicate in independent studies (Marchetti, 2023).

3.3. Bridges nodes between ED-symptoms and protective factors

We identified two conceptual communities, namely "ED-related symptoms" and "Protective factors". The first consisted of all the three EDI-3 subscales, namely B, DT, and BD. The second community listed all the factors related to positive body image, self-esteem, and intuitive eating, namely BAS-2, FAS, RSES, EPR, RHSC, UPE, and B-FCC. Then, we estimated bridge expected influence between the two communities for each node. Fig. 2 shows that five nodes had the highest negative expected influence, such as eating for physical rather than emotional reasons (EPR), drive for thinness (DT), and bulimic symptoms (B), body dissatisfaction (BD), body appreciation (BAS-2), and unconditional permission to eat (UPE), which were only partially statistically different from one another (Fig. S7; Supplementary Materials). In particular, the negative relation between eating for physical rather than emotional reasons (EPR) and bulimic symptoms (B) emerged as one of the most important bridges between the two communities. Moreover, although negatively related to drive for thinness (DT), unconditional permission to eat (UPE) had a substantially lower bridge expected influence (i.e., closer to zero), because it was positively associated with bulimic symptoms (B). Furthermore, body dissatisfaction (BD) and body appreciation (BAS-2) were negatively linked and showed moderate levels of bridge expected influence. Finally, confirming the antithetical relation between the "ED-related symptoms" and "Protective factors" communities, no node reported meaningful positive bridge expected influence values. Bridge expected influence was estimated in a very reliable way (i.e., CS-coefficient = 0.75).

3.4. Additional analyses

We estimated a graphical network for mixed-type data, where age, gender, and BMI index were used as possible moderators (Fig. S8; Supplementary Materials). Being a man was associated with reporting higher BMI; the latter was also positively linked with age. Moreover, being a man was associated with lower levels of body dissatisfaction (BD) and with higher levels of eating for physical rather than emotional reasons (EPR) and bulimic symptoms (B). Body dissatisfaction (BD) was also linked with higher BMI and age was negatively associated with both bulimic symptoms (B) and unconditional permission to eat (UPE). Importantly, age, gender, and BMI did not moderate any edge in the network. This network was estimated in a precise (Fig. S9; Supplementary Materials) reliable way (i.e., CS-coefficient for edges = 0.75).

4. Discussion

EDs and related symptoms constitute a major public health concern, as they are highly prevalent among both women and men and are associated with several negative consequences (Kärkkäinen et al., 2018; Keski-Rahkonen & Mustelin, 2016; Qian et al., 2021). However, despite the burgeoning literature on this topic, much remains still unknown, especially regarding the interplay between ED symptom dimensions and related protective factors (e.g., self-esteem, body and functionality

appreciation, and intuitive eating). Therefore, to provide a more fine-grained knowledge, we adopted a structural network analysis approach considering both ED symptom dimensions (i.e., drive for thinness, bulimic symptoms, and body dissatisfaction) and the protective factors mentioned above. We conducted this study under the lens of the positive psychology framework (Seligman & Csikszentmihalyi, 2000), which has been shown to be beneficial in the context of disordered eating, as it enables the identification of individual characteristics associated with reduced levels of maladaptive eating behaviors.

The network revealed that the nodes with the highest positive expected influence were functionality and body appreciation, which were also highly interrelated, both representing facets of positive body image. In particular, body appreciation showed strong positive and negative relations with, respectively, self-esteem and body dissatisfaction; in other words, participants who appreciate and respect their body are likely to present a better overall sense of self-worth and be less dissatisfied with their physical appearance. These findings are consistent with studies that widely support the existence of a direct association between positive body image and self-esteem (e.g., Alleva et al., 2017), as well as the protective role of body appreciation against the onset of body dissatisfaction (e.g., Linardon, 2021; Linardon et al., 2023; Linardon, McClure, et al., 2022).

Eating for physical rather than emotional reasons and unconditional permission to eat (i.e., two components of intuitive eating) emerged to be the nodes with the highest inverse influence and had different relations with ED symptom dimensions, in keeping with extant studies (Messer et al., 2022; Swami et al., 2021; Tylka & Kroon Van Diest, 2013). To be more specific, eating for physical rather than emotional reasons was negatively linked to bulimic symptoms; hence, individuals who listen to their body signals to determine what, when, and how much to eat are less inclined to eat according to situational/emotional factors.

Then, unconditional permission to eat had a strong negative relation with drive for thinness and body-food choice congruence; this would mean that people who allow themselves to eat different foods and do not try to stave off hunger present lower levels of desire to be thin and are less likely to match their food choices with their bodies' need. On the one hand, the inverse relation between unconditional permission to eat and drive for thinness is well-known in the literature (e.g., Linardon, 2021; Messer et al., 2022). On the other hand, the negative association between unconditional permission to eat and body-food choice congruence could sound counterintuitive and unexpected, as they both refer to the overarching construct of intuitive eating. However, it can be explained in light of Tylka and Kroon Van Diest (2013)'s consideration, that is people who indulge in eating a broad variety of foods and foods they crave (i.e., unconditional permission to eat) may not always select foods that give them energy and stamina (i.e., body-food choice congruence). At the same time, a note of caution is due here, since the relation between these two components of intuitive eating was not supported in the cross-validated network. Additional research is thereby needed to clarify this issue.

Taken together, these results lead to speculate that, of all variables included in the study, body and functionality appreciation as well as specific dimensions of intuitive eating (i.e., unconditional permission to eat and eating for physical rather than emotional reasons) may be the most relevant protective factors against ED symptoms and may constitute a primary preventive focus; hence, interventions that aim at teaching individuals to eat more intuitively and to love and respect their body may prove beneficial in preventing ED symptoms. Such interventions can help individuals nurture a healthier relationship with their bodies, ultimately reducing disordered behaviors and body dissatisfaction, aligning with the principles of the Embodied Self Model (Cook-Cottone, 2006). Nevertheless, it should also be kept in mind that centrality does not equate to causality (Bringmann et al., 2019; Dablander & Hinne, 2019); therefore, caution is recommended when interpreting the findings on centrality.

Subsequently, the above findings have been further supported and expanded when investigating nodes functioning as bridges between the two conceptual communities, namely "ED symptom dimensions" (i.e., drive for thinness, bulimia, and body dissatisfaction) and "Protective factors" (i.e., body and functionality appreciation, intuitive eating dimensions, and self-esteem). First, the strong, negative relation between eating for physical rather than emotional reasons and bulimic symptoms was one of the most important bridges; this result builds upon and extend previous findings (Christoph et al., 2021; Hazzard et al., 2021; Linardon et al., 2021) as it underscores the potential protective role of a specific intuitive eating process for bulimic symptoms. At the same time, given the cross-sectional nature of our study, it is also possible that the presence of bulimic symptoms and related psychological features (e.g., emotion dysregulation) hampers the implementation of an adaptive eating pattern focused on listening physical hunger drives rather than alleviating emotional distress. Indeed, bulimic symptoms stand at the opposite end of an eating style based on relying on physical rather than emotional signals, which determines what, when, and how much to eat (Linardon, 2021).

Another relevant bridge was the negative association between unconditional permission to eat and drive for thinness; hence, adopting this adaptive eating style might protect against the development of the desire to be thin and the consequent restrictive behaviors, in line with previous research emphasizing the protective role of intuitive eating for ED symptoms in general (Christoph et al., 2021; Hazzard et al., 2021; Linardon et al., 2021). Simultaneously, a different interpretation is also plausible; indeed, a strong desire to be thin may hinder the adoption of an eating style characterized by unrestricted consumption of desired foods. This hesitancy may be driven by a profound fear of weight gain, a common concern among individuals with significant thinness aspirations (Schmidt & Treasure, 2006). Thus, the fear of deviating from the desired body might contribute to a self-imposed restriction on the intake of desired foods. Overall, these findings can be explained by considering that allowing oneself to eat unconditionally is incompatible with the core features of dietary restriction observed in individuals with high drive for thinness levels, such as imposing strict limits on what and when to eat and having a list of foods that are forbidden. Indeed, people who eat intuitively do not classify foods as "good" or "bad" but provide their body with the food it needs to function optimally (e.g., Linardon, 2021; Messer et al., 2022). However, it should be noted that the bridge expected influence of unconditional permission to eat was lowered by its positive link with bulimic symptoms; therefore, it may also be that, under certain individual and environmental conditions, giving oneself the permission to eat unconditionally may increase the risk of overindulging in food. This result paves the way for future studies, which should delve into the relation between unconditional permission to eat and bulimic symptoms by also considering other variables/mechanisms potentially involved in it (e.g., emotion dysregulation, impulsivity).

The last relevant bridge, although less strong than the other ones, was the negative relation between body appreciation and body dissatisfaction. This result would emphasize the adaptive value of body appreciation and its pivotal role against the onset of negative feelings and thoughts about the body, in accordance with previous studies (e.g., Linardon, 2021; Linardon, McClure, et al., 2022). In particular, a reasonable explanation seems to be that individuals who love and respect their body also have a holistic view of the body; this is crucial for the development of gratitude towards one's own body and to develop a positive embodiment, factors found to reduce the risk of developing body dissatisfaction (Homan & Tylka, 2018; Piran, 2015).

Finally, gender, age, and BMI did not emerge as significant moderators, meaning that the specific relations between ED symptoms and protective factors were not a function of these variables. However, it is worth noticing that this evidence could be due to the characterization of the sample (i.e., non-clinical adults, both women and men, wide age range). Therefore, future investigations should try to replicate these findings by also considering at-risk individuals (e.g., youth) or patients with full-blown EDs. In particular, it is crucial to consider that disorder-

specific dynamics (for example, unique psychopathological processes and comorbid conditions) may be at play in individuals with diagnosed EDs; therefore, caution is warranted in generalizing the present results, which were obtained from a non-clinical sample, to clinical populations.

The present study has both strengths and limitations. Among the former is that it represents one of the first attempt to investigate the interplay between ED symptom dimensions and relevant protective factors with a structural network analysis design. Similarly, the inclusion of both women and men is also a strong point of our work, as most studies in this field have involved women only (e.g., DuBois et al., 2023; Rodgers et al., 2018). Moreover, the network analysis was based on a very large group of people, and this speaks in favor to the generalizability of our findings to Italian non-clinical adults. Moreover, it is worth stressing that the estimated network was precise and stable, as well as likely replicable in independent studies.

Among the limitations is, first, the sole use of self-report questionnaires, which can be subject to biases (e.g., misinterpretation of the questions). Moreover, we did not employ any measure of actual ED behaviors or EDs diagnostic criteria. Future investigations should thereby explore this topic by adopting different methods and measures (e.g., ecological momentary assessment, observational tools, clinical interviews, and implicit measures). Another shortcoming is related to the recruitment strategy based on social media: while distributing web-based surveys is resource-efficient and less time consuming, it may also introduce specific biases. For example, certain sociodemographic groups may be underrepresented (e.g., older individuals or those without Internet access) or overrepresented (e.g., younger individuals), thus leading to sampling bias. Moreover, people who choose to participate may be motivated by specific interests or concerns, potentially introducing bias towards certain perspectives. In addition, responses in a social media context might be less thoughtful or accurate compared to more controlled survey environments. Related to this point, participants of the current study were above 18 years old; therefore, the question of whether the findings of our study are equally applicable to adolescents below the age of 18 is currently unclear. Future studies may consider investigating the interplay between ED symptom dimensions and protective factors in younger participants, especially considering the high-risk of developing EDs and related symptoms in adolescence.

Importantly, our study is cross-sectional and correlational, thus not allowing strong conclusions about directionality. Therefore, future longitudinal research is encouraged in order to shed light on the directionality of the relation between the different constructs. Finally, another limitation is that predictability analysis showed that the variance in some intuitive eating dimensions (e.g., unconditional permission to eat, reliance on hunger and satiety cues, and body-food choice congruence) was little explained by the other variables in the network (see the results regarding node predictability). This would mean that the network probably lacks constructs that could be significantly associated with the nodes of the network. This evidence can offer important avenues for further investigations, which should take into account other constructs and phenomena potentially affecting intuitive eating (e.g., perfectionism, well-being, interoceptive awareness, and internalization of sociocultural beauty standards; Linardon et al., 2021).

5. Conclusions and practical implications

In conclusion, network analysis allowed us to make the first move in shedding light on the complex relations between ED symptom dimensions and related protective factors. The current results might have valuable practical implications, providing a useful framework for informing practitioners in the development of preventive interventions for ED symptoms, despite its correlational nature. This is especially the case, considering that ED symptoms are rapidly increasing and that a moderate degree of these symptoms is deemed normative among women (Wade et al., 2012). Nonetheless, if not adequately recognized and treated, symptoms can evolve into a structured psychological disorder; hence the importance of implementing prompt preventive interventions, not only addressing risk factors for EDs, but also protective factors. This approach aligns with the framework of positive psychology, which emphasize the integration of individuals' strengths and resilience in both prevention and treatment purposes. In particular, the strongest relations between ED symptom dimensions and protective factors turned out to be highly specific, since each ED symptom dimension was *specifically* linked to a protective factor: drive for thinness was associated with unconditional permission to eat, bulimic symptoms with eating for physical rather than emotional reasons, and body dissatisfaction with body appreciation. Therefore, preventive interventions promoting favorable opinions and attitudes towards the body (e.g., cognitive dissonance-based or yoga-based interventions, writing-based functionality interventions; Guest et al., 2019), unconditional permission to eat and eating for physical rather than emotional reasons (i.e., intuitive eating interventions) might be effective in reducing different facets related to ED symptom dimensions, including the desire to be thin, bulimic symptoms, and body dissatisfaction. This can be especially helpful to prevent the onset of ED and related symptoms, as emerged in previous studies showing the effectiveness of psychological interventions focusing on intuitive eating and positive body image in reducing ED symptoms (e.g., Babbott, Cavadino, Brenton-Peters, Consedine, & Roberts, 2023; Guest et al., 2019).

Ethical statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethical Committee of the Psychological Sciences of the University of Padova (approval code: 2871BB770B52DDDABE6903EFFD81C9C7).

CRediT authorship contribution statement

Silvia Cerea: Writing – review & editing, Writing – original draft, Methodology, Investigation, Data curation, Conceptualization. **Sara Iannattone:** Writing – review & editing, Writing – original draft. **Paolo Mancin:** Investigation, Data curation. **Gioia Bottesi:** Writing – review & editing, Supervision. **Igor Marchetti:** Writing – review & editing, Writing – original draft, Supervision, Formal analysis.

Declaration of competing interest

None.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2024.107326.

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