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Heterogeneity in sexual functioning among women with eating disorders: exploring the role of body trusting and need for approval using mixture regression modeling

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Abstract

Background Eating disorders (EDs) are associated with high heterogeneity of sexual dysfunction, but the underlying psychological mechanisms contributing to these difficulties have been poorly investigated. This study aimed to explore whether body trusting and need for approval, two core dimensions of ED psychopathology, are associated with differences in sexual desire across subgroups of women with EDs.

Methods A cross-sectional study was conducted with 348 women diagnosed with anorexia nervosa (AN), bulimia nervosa (BN), or binge-eating disorder (BED). Participants completed the Female Sexual Function Index, the Multidimensional Assessment of Interoceptive Awareness, and the Attachment Style Questionnaire. Mixture regression modeling was used to identify clusters based on the prediction of body trusting and need for approval on sexual desire. Multigroup structural equation modeling (SEM) was used to confirm the identified clusters.

Results Two clusters emerged. Cluster 1 showed a negative association of both need for approval and body trusting with sexual desire. Cluster 2 showed the opposite pattern, with both predictors positively associated with sexual desire. SEM confirmed the differential predictive pathways for these psychological traits across clusters membership in predicting desire.

Conclusions Women with EDs show opposite patterns of association between need for approval and body trusting with sexual desire. These findings suggest the utility of interventions targeting interoception and attachment-related features and highlight the importance of individualized approaches to promote sexual well-being in the treatment of EDs.

Plain English summary

Women with eating disorders may experience difficulties related to sexual well-being, ranging from low sexual desire or discomfort during intimacy to hypersexuality and risky sexual behaviours. This study aimed to explore

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the psychological mechanisms contributing to these difficulties focusing on two psychological traits, namely the need for others' approval and trusting the body's internal signals. Self-report questionnaires about sexuality, body awareness, and relationships were administered to 348 women with anorexia nervosa, bulimia nervosa, or binge-eating disorder. It was found that women with eating disorders were grouped into two subpopulations. In the first group, half of whom are individuals with anorexia nervosa, heightened need for approval and greater body trusting were linked to lower sexual desire. In the second group, which included two out of three women with bulimia or binge-eating disorder, heightened need for approval and greater body trusting were associated with higher sexual desire. These findings suggest that experiencing of the body as a safe place, along with fear of judgments and rejection, contributes to the heterogeneous sexual difficulties observed in women with eating disorders. Individualized treatments should be tailored to improve sexual well-being in women with eating disorders.

Keywords Eating disorders, Sexual desire, Body trusting, Need for approval, Mixture regression, Structural equation modeling

Introduction

Eating disorders (EDs), including anorexia nervosa (AN), bulimia nervosa (BN), and binge eating disorder (BED), are characterized by persistent disturbances in eating or weight-control behaviours that significantly impair physical health and psychosocial functioning [1], representing a significant public health concern. While the adverse effects on physical and mental health are well-established, the impact on sexual health, a critical component of overall well-being [2], is increasingly recognized as a prevalent and clinically relevant issue requiring further investigation [3–5].

A growing body of literature has demonstrated a high prevalence of sexual dysfunction with high heterogeneity among women with EDs compared to healthy controls, ranging from loss of sexual desire and impaired arousal to hypersexuality and risky sexual behaviors [3, 4, 6, 7]. These difficulties typically present as reduced sexual desire (or loss of libido), as well as impairments in arousal, lubrication, orgasm, satisfaction, and increased sexual pain [3, 4, 6] resulting in sexual anxiety and avoidance of sexual relationships. On the other hand, hypersexual and risky sexual behaviours are also often reported in women with EDs, and are characterized by urgency to engage in sexual activity, intrusive sexual thoughts, unprotected sex, sex with multiple partners, or sexual activity in unsafe contexts [8–10]. While several factors have been proposed to explain these difficulties, including medical complications (namely, underweight and estrogens deficit) [4], psychological dimensions (namely, impulsivity, embodiment, and attachment style) [11], and specific eating disorder psychopathology (namely body and weight dissatisfaction) [4, 6, 7], the factors associated with the observed heterogeneity in sexual functioning among women with EDs remain unclear.

Among non-clinical populations, research in this area has identified several psychological and relational determinants of sexual functioning and satisfaction, characterized by the interplay of physiological, psychological, and relational factors. Within this framework of psychological

and relational influences, the impact of attachment styles on sexual experience is critical. Specifically, research highlights that insecure attachment, characterized by a preoccupation with relationships, a constant need for approval, and heightened sensitivity to the actions of others, can significantly impact sexual dynamics [12]. Among those with anxious attachment, sexual desire may secure intimacy and closeness [13]. Furthermore, as demonstrated by Ciocca et al. [12], the need for approval is a predictive factor for female sexual dysfunction, underscoring the critical role of a secure base in relationships for healthy sexual function. Concurrently, the ability to accurately perceive and trust internal bodily signals is strongly linked to sexual satisfaction in non-clinical populations [14, 15]. Dixon et al. [16] consistently showed that a greater body trusting, reflecting the belief in the reliability and safety of one's own bodily sensations, is associated with higher levels of sexual arousal, orgasm frequency, and satisfaction in both solo and partnered.

The above-mentioned psychological dimensions are core features of EDs, as both the perception and confidence towards body signals and insecure attachment contribute to the complex clinical presentation of ED [17, 18]. These individuals often exhibit heightened interpersonal difficulties, including a marked fear of rejection, an elevated need for approval, and an acute sensitivity to judgment [19]. This need is often associated with insecure attachment styles [20], especially anxious attachment, and helps to maintain interpersonal relationships even at the cost of personal well-being [21, 22]. In the context of EDs, where interpersonal difficulties are pervasive, an anxious attachment style, characterized by fear of abandonment and intense needs for closeness and validation [23], has been linked to ED symptoms such as body dissatisfaction [21] and could directly impact sexual functioning [11]. Therefore, the need for approval, as a specific manifestation of anxious attachment, represents a crucial psychopathological dimension to be explored in relation to sexual dysfunction in EDs.

The relationship with one's body is a further core dimension of ED psychopathology [24, 25]. Beyond established concepts like body dissatisfaction and body image distortion, understanding the subjective experience of body in individuals with EDs has been widely acknowledged as highly relevant [9]. Feeling extraneous from the body and need to define oneself through external measures are transdiagnostic psychopathological features of EDs [26]. Within this broader understanding of corporeality, interoception, defined as “the process by which the nervous system senses, interprets, and integrates signals originating from within the body”, emerges as a key factor [27] contributing to maladaptive eating behaviors and a general disconnection from bodily self [28, 29]. Recent evidence strongly suggests that interoceptive dysfunction may contribute to both disordered eating and sexual difficulties among healthy women, acting as a potential “third variable” linking these concomitant outcomes [14]. Among interoceptive dimensions body trusting, that is the extent to which own bodily sensations are perceived as reliable and safe, appears particularly relevant in EDs [28, 30]. A reduced capacity to trust one's internal desire is crucial in EDs, where individuals often override hunger or satiety signals and experience a disconnection from their physiological states as well as from their emotions [31]. Impaired confidence towards body signals in EDs is influenced by early attachment interactions as early insecure attachment interactions may hinder the development of a coherent bodily self, limiting the ability to trust and rely on internal signals and contributing to impaired confidence towards body signals in EDs [32, 33].

Considering the central role of relational difficulties (specifically, the need for approval stemming from anxious attachment) and of impaired body trusting in the psychopathology of EDs, this study aims to investigate how these factors may contribute to the heterogeneity observed in sexual functioning among women with EDs. By employing mixture regression modeling, a statistical technique capable of highlighting latent clusters based on different predictors of a phenomenon rather than on the levels of the phenomenon itself, we aim to identify distinct subgroups of women with EDs based on their sexual functioning patterns and to explore the predictive roles of body trusting and need for approval in distinguishing these subgroups. We hypothesize that women with EDs exhibit different patterns of sexual functioning, and that higher levels of need for approval and lower levels of body trusting are associated with greater sexual dysfunction.

Methods

This was an observational cross-sectional study on a sample of patients with EDs enrolled at University of Campania L. Vanvitelli and University of Florence.

Participants

Participation in the study was proposed to patients during their first access to the specialized ED outpatient clinics of the facilities involved. The inclusion criteria were: female gender, age between 18 and 65 years, presence of AN, BN or BED according to DSM-5 criteria at clinical evaluation and confirmed by the Structured Clinical Interview for DSM-5 [34]. The exclusion criteria were: presence of comorbid psychotic or bipolar disorder according to DSM-5 criteria, presence of illiteracy or intellectual disabilities or other conditions potentially precluding correct understanding of the study or testing, absence of written informed consent.

All patients underwent an initial evaluation by a psychiatrist experienced in EDs, during which inclusion and exclusion criteria were assessed and participation in the study was proposed if appropriate. Participants who accepted subsequently completed the psychometric evaluations described later, in any case before the start of any treatment.

This study was performed in line with the principles of the Declaration of Helsinki and was approved by the Institutional Ethics Committee of “Area Vasta Centro—CEAVC” (reference number: OSS.14.162) and by the University of Campania L. Vanvitelli Ethic Committee (reference number: 0015736/i).

Assessment

In the context of clinical evaluation, the participants' sociodemographic data were collected, and height and body weight were measured to calculate the Body Mass Index (BMI). They were asked to fill in the following psychometric tests:

- *Multidimensional Assessment of Interoceptive Awareness (MAIA) 2.0* [35, 36]. A 37-item questionnaire for the assessment of multiple dimensions related to interoception. It provides 8 scores, related to: awareness of body sensations (Noticing), tendency not to let go of negative sensations (Not-Distracting), tendency not to associate negative emotions or worry with negative sensations (Not-Worrying), ability to manage attention to body sensations (Attention Regulation), awareness of the connection between emotional states and bodily sensations (Emotional Awareness), ability to manage distress with attention to body sensations (Self-Regulation), active listening to the body for insight (Body Listening), and experience of the body as a safe place (Trusting). Higher scores indicate better interoceptive abilities. Internal consistency in the present sample was very high (Cronbach's $\alpha = 0.91$).

- *Female Sexual Function Index (FSFI)* [37]. A 19-item multidimensional tool for assessing female sexual function across all its domains. It provides a general sexual function index (Total Score), along with subscales related to: sexual desire (Desire), arousal (Arousal), genital lubrication (Lubrication), orgasmic function (Orgasm), general satisfaction with sexual relationships and sexual life (Satisfaction), and levels of pain during vaginal penetration (Pain). It is often considered the de facto “gold standard” for assessing female sexuality [38]. Higher scores indicate better sexual functioning on all scales, including the one related to sexual pain (i.e., higher scores mean less pain). Since all items, except for those related to Desire and Satisfaction, assume the presence of sexual activity, the FSFI Desire subscale was used as the primary outcome variable, consistent with previous studies [11, 39]. Internal consistency in the present sample was excellent (Cronbach's $\alpha = 0.98$).
- *Attachment Style Questionnaire (ASQ)* [40]. A 40-item scale for assessing adult attachment style. It provides two subscales indicating an anxious insecure attachment style (Preoccupation with Relationships, Need for Approval), two indicating an avoidant insecure attachment style (Discomfort with Closeness, Relationships as Secondary), and one related to a secure attachment style (Confidence). Internal consistency in the present sample was very high (Cronbach's $\alpha = 0.88$).
- *Beck Depression Inventory (BDI)* [41]. A widely used scale for assessing depressive symptomatology. It provides a single score, with higher scores indicating more severe symptomatology.

For the purposes of this study, the FSFI Desire subscale ($\alpha = 0.93$), the ASQ Need for Approval ($\alpha = 0.86$) subscale, and the MAIA Trusting ($\alpha = 0.88$) subscale were used.

Statistical analysis

All statistical analyses were performed using R statistical software v.4.4.3 [42], and the following libraries: dplyr [43], lavaan [44], RobMixReg [45].

Descriptive statistics were reported as mean and standard deviation, frequency and percentage or median and 25th–75th percentiles where appropriate. Comparisons between groups across different ED diagnoses were conducted using age-adjusted Analysis of Covariance (ANCOVA), with post hoc comparisons performed using Tukey's method for multiple comparisons. For age and illness durations, comparisons were performed using Kruskal–Wallis tests, with Wilcoxon rank sum tests for post hoc analyses (Bonferroni-adjusted p values).

To identify subgroups within the sample of ED patients characterized by different predictors of sexuality, the

statistical plan included a preliminary exploratory analysis using robust mixture of regression clustering, followed by a confirmatory multigroup structural equation modeling (SEM) analysis on the identified clusters.

Mixture of regression is a type of analysis that combines clustering techniques with regression models. It allows the discovery of hidden group memberships within a large and heterogeneous population, uncovering subpopulations with distinct characteristics and data patterns. In the study sample two clusters were expected, characterized by a different relationship between anxious attachment style and interoceptive confidence with sexuality. FSFI Desire was chosen as the outcome (dependent) variable, as it is the only subscale of FSFI that allows the assessment of sexual drive even in the absence of any sexual activity. To facilitate model convergence, jittering of the data was applied within a ± 0.3 range. As supported by previous research [12, 14, 28], predictors were identified as ASQ Need for Approval (as an indicator of anxious insecure attachment) and MAIA Trusting (as an indicator of interoceptive confidence). To enhance the reliability of the analysis and mitigate the influence of outliers or deviations from normality, the robust Trimmed Likelihood Estimator (TLE) algorithm was implemented, allowing the analysis to be performed on a trimmed dataset with a threshold of 5%. For the data-driven identification of the number of clusters, solutions with both 2 and 3 clusters were computed, and the best was selected by calculating the Bayesian Information Criterion (BIC, lower values indicate a better model fit). To confirm the validity of the clusters and improve the interpretability of the analysis, a linear regression model was computed where the interactions between the clusters and the predictors, along with the main effects, were included.

Once the clusters were identified, between-group comparisons were performed regarding clinical-psychometric characteristics using ANCOVA (as described above). Furthermore, the association between the presence of a specific ED diagnosis and belonging to a specific cluster was verified through binomial logistic regression.

Finally, a confirmatory full multigroup SEM model was computed. Multigroup analysis on latent factors presupposes the presence of preliminary conditions regarding invariance, which were verified. The confirmation of configural invariance, metric (weak) invariance, and scalar (strong) invariance between groups for the latent constructs is essential to ensure that any differences between groups are not due to measurement artifacts [46]. For configural invariance, a multigroup Confirmatory Factor Analysis (CFA) model was computed (with patient clusters as groups), verifying the presence of acceptable fit indices. Three latent variables were considered: Interoceptive Confidence (with loadings on the three manifest variables MAIA Trusting, Body Listening,

and Self-Regulation), Anxious Attachment (with loadings on ASQ Need for Approval and Preoccupation with Relationships), and Avoidant Attachment (with loadings on ASQ Discomfort with Closeness and Relationships as Secondary). In this context, the following parameters are considered indicators of good fit: Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI) ≥ 0.95 , Root Mean Square Error of Approximation (RMSEA) < 0.06 , Standardized Root Mean Square Residual (SRMR) < 0.08 [47]. In the presence of configural invariance, metric and scalar invariance are verified by testing nested CFA models with constrained loadings and loadings/intercepts, respectively: non-significant chi-squared difference tests for these nested models confirm weak and strong invariances. The final multigroup SEM model was set up with regression pathways from the three latent constructs described above to predict FSFI Desire, calculating loadings, intercepts, variances, covariances, and regressions separately between patient clusters. The regression coefficients were then constrained to be equal across clusters, and the nested model was compared with the unconstrained one using a chi-squared difference test: a statistically significant test indicates an actual difference between clusters in terms of regression pathways. It is important to note that the aim of the present study was to provide experimental evidence regarding the proposed theoretical model. This kind of analysis typically does not require split-sample validation procedures, which can significantly reduce statistical power and are instead reserved for the development of predictive models to be applied for external predictions (e.g., in the context of machine learning analyses). Consequently, all analyses were performed on the full sample.

For all models, both unstandardized (b) and standardized (β) coefficients were reported, except for the logistic regression models, for which the exponentiated coefficients (equivalent to the odds ratios, ORs) were reported, along with their respective p values. In the CFA and SEM models, robust Huber-White standard errors were computed, and the robust versions of CFI, TLI, and RMSEA were used. In the final SEM model, covariances among the three latent constructs and between MAIA Body Listening and Self-Regulation were allowed. To ensure that the model was identified, all variances of latent constructs were fixed to one.

Sensitivity analyses

Since the results of predictive models are known to largely depend on the independent variables that are chosen, a series of sensitivity analyses were conducted to test the robustness of the results in the presence of covariates and to provide further rationale behind the overall selection of predictors. Specifically, given their possible association with sexual functioning, the following covariates

were tested: age, BMI, and depressive symptomatology (BDI score). These variables were individually added to the final SEM model as predictors of sexual desire, and the resulting model was tested against the one without the added predictor using the Vuong test for non-nested models and by evaluating fit indices.

A priori power analysis

An a priori power analysis was conducted to determine the minimum sample size in order to obtain an adequate clustering using a mixture of regression analysis, through a Monte Carlo simulation with 500 replications for each sample size (sample sizes tested: 50, 100, 150, 200, 250, 300). Based on previous literature on the topic [11, 48] and descriptive statistics produced on preliminary samples, data were generated for MAIA Trusting (mean = 1.50, standard deviation = 1.40) and ASQ Need for Approval (mean = 25.00, standard deviation = 8.00), and for FSFI Desire (centered on a mean of 3.00). The Monte Carlo simulation revealed that a sample of at least $n = 150$ was necessary to identify with 80% power 2 clusters (through the BIC criterion, compared to a single cluster solution) with statistically significant MAIA*Cluster and ASQ*Cluster interactions ($\alpha = 0.05$), in the presence of medium effects (standardized coefficients $\beta = -0.30$ in the first cluster and $\beta = 0.30$ in the second). With the same parameters, a sample of $n = 250$ identified the same solution in 90% of cases, and one of $n = 300$ in 96%.

Furthermore, the a priori power calculation indicated that the required sample size to detect misspecifications of a SEM model (involving $df = 28$ degrees of freedom, namely those of the multi-group model proposed for the present study) corresponding to RMSEA = 0.06 with a power of 90% ($\alpha = 0.05$) was $n = 295$. Finally, the required sample size to discriminate a model exhibiting an RMSEA of 0.06 on 28 degrees of freedom from a model with RMSEA = 0.08 on 31 degrees of freedom (namely a model where the regression factors of the FSFI Desire predictors were constrained across clusters) with a power of 90% was $n = 147$.

Based on the above, a recruitment target of $n = 300$ subjects was deemed necessary, which allowed achieving a statistical power greater than 90% for both the mixture of regression analysis and the multi-group SEM model. Consequently, the final sample of $n = 348$ was considered satisfactory in terms of balance between Type I and Type II error. All a priori power calculations regarding the SEM models were performed using the *semPower* R library [49].

Results

General characteristics of the sample

The final sample consisted of 348 patients diagnosed with EDs, including 137 with AN, 135 with BN, and 76 with

Table 1 General and psychometric characteristics of the sample, divided by diagnosis

	Anorexia nervosa (<i>n</i> = 137)	Bulimia nervosa (<i>n</i> = 135)	Binge- eating disorder (<i>n</i> = 76)	<i>F</i> / χ^2
BMI (kg/m ²)	16.32 ± 1.58 ^{†,‡}	23.52 ± 5.25 [‡]	36.85 ± 8.91	292.71***
Age (years)	21 [18–25] ^{†,‡}	24 [20–30] [‡]	29.5 [11, 21–44]	39.63***
Illness dura- tion (years)	2.5 [1–6.5] ^{†,‡}	6 [2.5–13]	9 [4–17]	41.31***
MAIA noticing	2.75 ± 1.17 [‡]	3.06 ± 1.17	3.27 ± 1.24	3.63*
MAIA not-distracting	2.64 ± 1.05	2.56 ± 0.99 [‡]	2.91 ± 1.08	3.56*
MAIA not-worrying	2.23 ± 1.12	2.34 ± 1.25	2.43 ± 1.21	0.21
MAIA at- tention regulation	2.16 ± 1.05	2.23 ± 1.19	2.30 ± 1.22	0.00
MAIA emotional awareness	2.59 ± 1.18	3.05 ± 1.38	3.08 ± 1.36	2.60
MAIA self-regulation	1.47 ± 1.02	1.55 ± 1.21	2.03 ± 1.30	2.23
MAIA body listening	1.53 ± 1.17	1.65 ± 1.33	1.87 ± 1.44	0.39
MAIA trusting	1.25 ± 1.33	1.21 ± 1.35	1.41 ± 1.42	0.83
FSFI desire	2.53 ± 1.43 [‡]	3.20 ± 1.46	3.03 ± 1.44	7.63***
FSFI arousal	1.69 ± 1.78 [‡]	2.64 ± 2.07	2.16 ± 2.11	8.27***
FSFI lubrication	1.91 ± 2.19 [‡]	2.90 ± 2.28	2.46 ± 2.42	6.21**
FSFI orgasm	1.57 ± 1.99 [‡]	2.77 ± 2.25	2.25 ± 2.26	10.50***
FSFI satisfaction	2.25 ± 1.70	2.71 ± 2.02	2.12 ± 1.88	3.25*
FSFI pain	1.70 ± 2.32 [‡]	2.59 ± 2.46	1.89 ± 2.41	4.80**
FSFI total score	11.67 ± 9.81 [‡]	16.84 ± 11.02	13.91 ± 10.92	8.16***
ASQ confidence	23.41 ± 6.65	25.07 ± 8.40	26.74 ± 7.96	1.81
ASQ discom- fort with closeness	44.99 ± 8.20 [‡]	42.47 ± 10.37	40.87 ± 8.95	3.67*
ASQ relation- ships as secondary	19.87 ± 7.54	19.39 ± 7.28	17.45 ± 6.64	1.57
ASQ need for approval	29.85 ± 8.33	28.41 ± 9.03	25.59 ± 7.88	1.79
ASQ preoc- cupation with relationships	32.96 ± 7.94	32.54 ± 8.11	31.18 ± 7.77	0.11
BDI total score	25.26 ± 11.89 ^{†,‡}	21.37 ± 11.46	18.47 ± 10.40	8.92***

ASQ Attachment Style Questionnaire, BDI Beck Depression Inventory, BMI Body Mass Index, FSFI Female Sexual Function Index, MAIA Multidimensional Assessment of Interoceptive Awareness

Group comparisons are reported using *F*-values/Kruskal–Wallis χ^2 statistics, *p* values (* < 0.05, ** < 0.01, *** < 0.001), and the results of post-hoc comparisons ([†]significantly different from bulimia nervosa, [‡]significantly different from binge-eating disorder)

BED. The general and psychopathological characteristics of the three groups are presented in Table 1. Comparisons between diagnoses revealed that patients with BED were generally older than the others, while those with AN were the youngest (Table 1).

Patients with AN displayed poorer sexual functioning compared to those with BN, as well as a greater tendency toward insecure attachment across various dimensions of the Attachment Style Questionnaire (ASQ) compared to patients with BED (Table 1). Similarly, patients with AN and BN showed differences on the MAIA subscales compared to those with BED. More specifically, individuals with AN exhibited lower scores on the MAIA Noticing subscale, indicating reduced awareness of bodily sensations, whereas individuals with BN scored lower on the MAIA Not-Distracting subscale, suggesting a diminished tendency to avoid or disengage from negative bodily sensations (Table 1).

Clustering with mixture of regression models

Robust Mixture of Regression Models were used to cluster the sample into distinct subgroups, based on the relationships between ambivalent insecure attachment (ASQ Need for Approval) and interoceptive confidence (MAIA Trusting) with sexual desire (FSFI Desire). Two-cluster and three-cluster solutions were computed and compared by calculating their respective BIC parameters. The two-cluster model was selected, both for its better adherence to the a priori theory underlying the study and for its lower BIC ($BIC_{2\text{-cluster}} = 1116.48$) compared to the three-cluster model ($BIC_{3\text{-cluster}} = 1123.21$).

In the two-cluster solution, two subgroups of patients were identified with sizes of 105 and 225 respectively, with a trimming of 18 patients (5% of the entire sample) as per the TLE technique.

The first cluster was composed of half patients diagnosed with AN (*n* = 53, 50.5%), one third with BN (*n* = 35; 33.3%) and 16.2% (*n* = 17) with BED.

The second cluster was composed of more than a third patients diagnosed with BN (*n* = 92, 40.9%), a quarter with BED (*n* = 57, 25.3%) and a third (*n* = 76; 33.8%) with AN.

The linear regression model in the first cluster (*n* = 105) showed a negative association between ASQ Need for Approval ($b = -0.13$, $\beta = -0.97$, $p < 0.001$) and MAIA Trusting ($b = -0.27$, $\beta = -0.28$, $p < 0.001$) with FSFI Desire ($b_0 = 6.08$, $p < 0.001$). In the second cluster (*n* = 225), the model displayed a positive association with sexual desire levels for both ASQ Need for Approval ($b = 0.07$, $\beta = 0.46$, $p < 0.001$) and MAIA Trusting ($b = 0.34$, $\beta = 0.37$, $p < 0.001$; $b_0 = 0.56$, $p = 0.09$). The clusterization was further confirmed by computing a single linear regression model moderated by cluster membership, with results reported

Table 2 Coefficients of the linear regression model predicting FSFI desire

	Estimate (b)	Standardized β	Std. error	p value	95% CI (lower bound)	95% CI (upper bound)
(Intercept)	6.04	–	0.36	<0.001	–	–
ASQ need for approval	–0.13	–0.82	0.01	<0.001	–0.84	–0.80
Cluster 2 (vs. Cluster 1)	–5.44	–1.92	0.45	<0.001	–2.81	–1.02
MAIA trusting	–0.27	–0.28	0.08	<0.001	–0.43	–0.13
‘Cluster 2’*‘ASQ’	0.20	2.18	0.01	<0.001	2.15	2.21
‘Cluster 2’*‘MAIA trusting’	0.61	0.61	0.09	<0.001	0.42	0.79

The table reports unstandardized estimates

ASQ Attachment Style Questionnaire, FSFI Female Sexual Function Index, MAIA Multidimensional Assessment of Interoceptive Awareness

Interaction Effects on Sexual Desire

Cluster as moderator

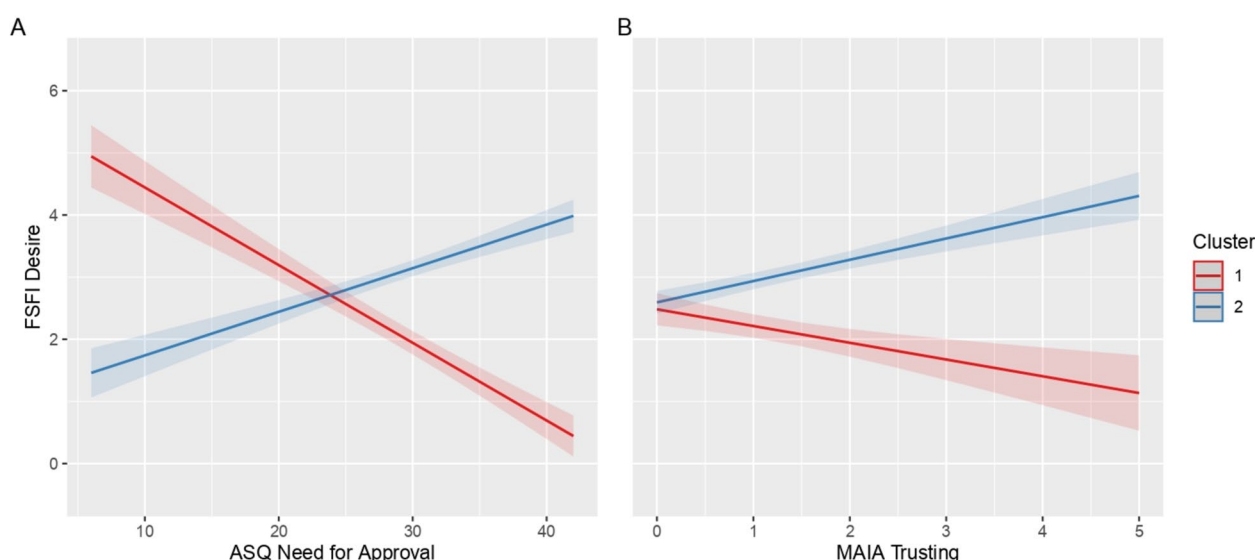


Fig. 1 Interaction plots illustrating the moderating effect of cluster membership on the relationship between predictor variables and sexual desire. Panel **A** depicts the interaction between ASQ need for approval (x-axis) and cluster membership (Cluster 1: red line; Cluster 2: blue line) in predicting FSFI sexual desire (y-axis). Panel **B** depicts the interaction between MAIA trusting (x-axis) and cluster membership in predicting FSFI sexual desire (y-axis). Lines represent the estimated regression slopes for each cluster, derived from the moderation analysis. Shaded areas around the lines represent the 95% confidence intervals for the predicted values. ASQ, Attachment Style Questionnaire; FSFI, Female Sexual Function Index; MAIA, Multidimensional Assessment of Interoceptive Awareness

in Table 2. The interaction between Cluster and predictors of sexual desire is illustrated in Fig. 1.

Comparisons between clusters, as reported in Table 3, revealed statistically significant differences in sexual functioning, which was more impaired in Cluster 1. Additionally, higher BMI and greater levels of MAIA Emotional Awareness were observed in Cluster 2 (Table 3). Binomial logistic regression analyses indicated that the patients' diagnoses had predictive power regarding cluster membership, with an association between belonging to Cluster 2 and diagnoses of BN (OR = 1.83, $p = 0.023$) or BED (OR = 2.34, $p = 0.010$).

Multigroup structural equation modeling analysis

Before proceeding with the multigroup SEM analysis, preliminary conditions of configural invariance, metric (weak) invariance, and scalar (strong) invariance

were verified. The initial unconstrained multigroup CFA model, which specified the same structure for latent variables related to Interoceptive Confidence, Anxious Attachment, and Avoidant Attachment, showed excellent fit indices (robust CFI = 0.984; robust TLI = 0.969; robust RMSEA = 0.057; SRMR = 0.038), confirming configural invariance across clusters. Two nested CFA models were then compared to this initial model, with constraints on equal loadings and equal loadings/intercepts, respectively. Non-significant chi-squared difference tests for these nested models indicated that constraining loadings and intercepts did not worsen model fit, confirming metric invariance ($\Delta\chi^2 = 1.90$, $p = 0.755$) and scalar invariance ($\Delta\chi^2 = 0.74$, $p = 0.946$). These preliminary tests suggested that any group differences in structural paths would reflect true differences in relationships between

Table 3 General and psychometric characteristics of the sample, divided by cluster

	Cluster 1 (n = 105)	Cluster 2 (n = 225)	F/χ^2
BMI (kg/m ²)	21.49 ± 8.28	24.61 ± 9.86	5.97*
Age (years)	22 [19–27]	23 [20–31]	2.68
Illness duration (years)	5 [2–10]	4 [2–11]	0.09
MAIA noticing	2.91 ± 1.30	3.02 ± 1.16	0.29
MAIA not-distracting	2.68 ± 1.02	2.66 ± 1.06	0.01
MAIA not-worrying	2.14 ± 1.07	2.39 ± 1.25	2.51
MAIA attention regulation	2.03 ± 1.10	2.28 ± 1.14	2.49
MAIA emotional awareness	2.59 ± 1.35	2.99 ± 1.29	4.99*
MAIA self-regulation	1.55 ± 1.14	1.68 ± 1.21	0.31
MAIA body listening	1.55 ± 1.28	1.70 ± 1.32	0.56
MAIA trusting	1.16 ± 1.31	1.35 ± 1.40	0.68
FSFI desire	2.10 ± 1.25	3.04 ± 1.26	40.71***
FSFI arousal	1.24 ± 1.52	2.48 ± 2.01	32.46***
FSFI lubrication	1.28 ± 1.88	2.85 ± 2.27	38.17***
FSFI orgasm	1.24 ± 1.85	2.57 ± 2.22	28.77***
FSFI satisfaction	1.83 ± 1.61	2.63 ± 1.88	15.34***
FSFI pain	1.26 ± 2.08	2.40 ± 2.45	17.00***
FSFI total score	8.94 ± 8.87	15.96 ± 10.50	35.79***
ASQ confidence	23.99 ± 7.95	25.15 ± 7.61	1.01
ASQ discomfort with closeness	43.74 ± 9.20	42.60 ± 9.53	0.77
ASQ relationships as secondary	19.70 ± 7.72	19.04 ± 7.12	0.31
ASQ need for approval	29.05 ± 9.69	28.19 ± 8.23	0.19
ASQ preoccupation with relationships	32.43 ± 8.08	32.43 ± 8.01	0.07
BDI total score	24.32 ± 12.56	21.27 ± 11.14	4.97*

ASQ Attachment Style Questionnaire, BDI Beck Depression Inventory, BMI Body Mass Index, FSFI Female Sexual Function Index, MAIA Multidimensional Assessment of Interoceptive Awareness

Group comparisons are reported using F -values/Kruskal–Wallis χ^2 statistics and p values (* < 0.05; ** < 0.01, *** < 0.001)

constructs rather than measurement artifacts, allowing progression to a multigroup SEM model.

The final multi-group SEM model is shown in Fig. 2. The fit indices were excellent, with robust CFI = 0.989, robust TLI = 0.978, robust RMSEA = 0.048, and SRMR = 0.042. The analysis confirmed the role of interoceptive confidence and anxious attachment as negative predictors of sexual desire in cluster 1, and as positive predictors in cluster 2 (Fig. 2). Conversely, no significant effect was found regarding the latent variable relating to avoidant adult attachment (Fig. 2).

Finally, the comparison between the multigroup SEM model and a nested model with constrained regression coefficients across clusters showed statistically significant differences, as indicated by a chi-square difference test ($\Delta\chi^2 = 69.00$, $p < 0.001$). This result confirmed that the unconstrained model, which allowed regression coefficients to vary between clusters, provided a better fit to

the data than the nested model enforcing equality across groups.

Sensitivity analyses

Vuong tests highlighted that adding age or BMI as predictors of sexual desire to the aforementioned multigroup SEM model did not significantly improve the fit (both $p < 0.05$ in favor of the alternative hypothesis that the original model was better than the one with the additional predictor). From the results of these models, age and BMI were not significant predictors (both $p > 0.05$ in both clusters), while the remaining coefficients were substantially unchanged.

However, regarding depressive symptomatology, the Vuong test did not yield conclusive results, showing a marginally significant variance test ($p = 0.046$, indicating that the two models were distinguishable from each other) but no preference between the model with or without the BDI score as a predictor of sexual desire (both alternative hypotheses with $p > 0.05$). The results of the integrated model showed that BDI was a statistically significant negative predictor only in cluster 2 ($b = -0.02$, $\beta = -0.16$, $p = 0.022$), while it was not in cluster 1 ($b = 0.01$, $\beta = 0.08$, $p = 0.153$); the remaining coefficients in the two clusters remained substantially unchanged. In any case, in the absence of a decisive Vuong test, the integrated model with BDI was rejected according to both the principle of parsimony and the unsatisfactory fit indices (CFI = 0.868, robust TLI = 0.774, robust RMSEA = 0.146, and SRMR = 0.142).

In conclusion, sensitivity analyses confirmed that the results obtained with the multigroup SEM model in relation to the research hypotheses are stable even in the presence of possibly relevant covariates.

Discussion

The present study investigated the relationship between key psychological factors, namely body trusting and need for approval, and sexual desire among women seeking treatment for EDs, including AN, BN and BED. Using robust mixture regression modeling followed by multigroup SEM, the primary finding was the identification of two distinct subgroups, characterized by significantly different, even opposite, patterns of association between anxious attachment features, namely the need for approval, and body trusting with sexual desire. This result provides empirical support for the hypothesized heterogeneity within the ED population regarding the psychological correlates of sexual desire.

The mixture regression analysis identified a two-cluster grouping, highlighting distinct insights into the interplay between the selected predictors and sexual desire. Cluster 1, which included about one-third of the sample, showed negative associations between both need for approval

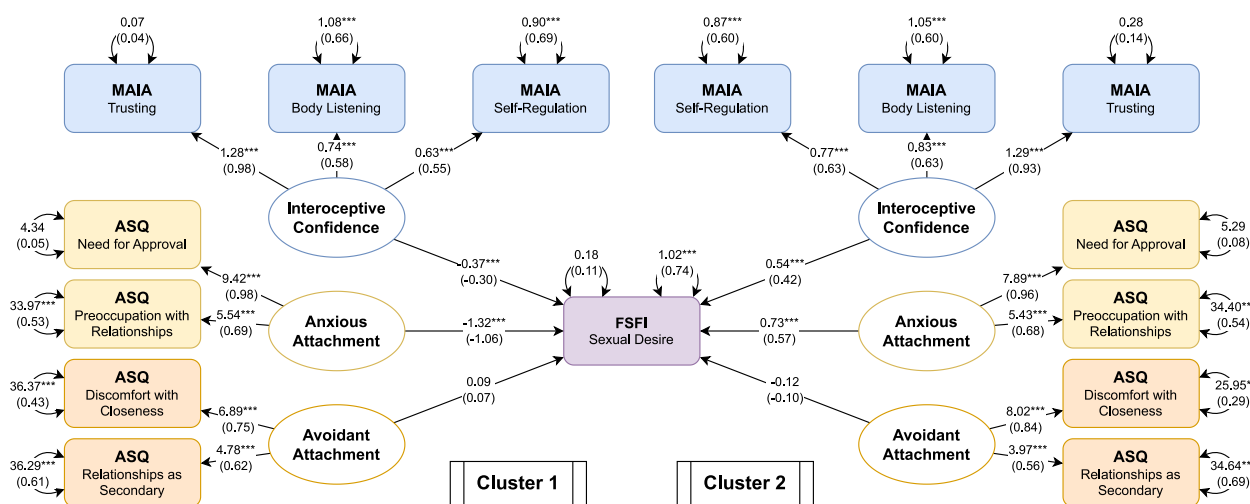


Fig. 2 Multigroup structural equation model of the associations between interoceptive awareness, attachment styles, and sexual desire across two distinct clusters. Ellipses represent latent constructs, while rounded rectangles represent observed indicator variables (MAIA, ASQ, FSFI). Variables related to interoceptive awareness are shown in light blue, whereas variables related to attachment are shown in light orange/yellow. The outcome variable, FSFI Sexual Desire, is shown in purple. Single-headed arrows represent hypothesized directional relationships: factor loadings (from latent variables to their indicators) and regression paths. Path coefficients are reported as unstandardized estimates, with their respective p values; standardized estimates are shown in parentheses below them. Double-headed curved arrows represent residual variances (pointing from a variable to itself). The model structure is presented separately for Cluster 1 (left) and Cluster 2 (right). * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. ASQ, Attachment Style Questionnaire; FSFI, Female Sexual Function Index; MAIA, Multidimensional Assessment of Interoceptive Awareness

and body trusting with sexual desire. The negative relationship between need for approval and sexual desire aligns with theoretical models suggesting that heightened fear of negative evaluation and rejection sensitivity, central in the anxious attachment style [50, 51] may inhibit sexual interest, particularly within the context of ED-related body image concerns [52]. This pattern is consistent with research indicating sexual disinvestment among individuals with EDs, especially among those exhibiting restrictive eating behaviours [3, 4]. Conversely, Cluster 2 showed a positive association between need for approval and sexual desire. This result could suggest that the need of closeness and validation associated with attachment anxiety [50] might translate into heightened sexual motivation in this subgroup, potentially to achieve relational security or regulate affect, aligning with some conceptualizations of dysregulated eating behaviours (i.e. binge-purging) as a strategy to manage emotional dysregulation in interpersonal contexts [53–55].

The negative association between heightened body trusting and lower sexual desire observed in Cluster 1 adds complexity to a literature marked by mixed findings. While some studies in non-clinical samples associated greater interoception with improved sexual functioning [14, 15], others found that in women with AN, higher interoceptive confidence was linked to greater loss of libido, especially among those with lower BMI and higher trait anxiety [4]. In the latter cases, increased bodily awareness may intensify discomfort or distress, thereby inhibiting desire. Our findings align with this

interpretation: within a subgroup of individuals with EDs, body trusting may paradoxically amplify the perception of internal states as aversive. This suggests that the impact of interoception on sexuality may be context-dependent, influenced by the meaning ascribed to bodily sensations. In contrast, Cluster 2 highlighted a positive association between body trusting and sexual desire. This positive association is consistent with findings indicating that enhanced awareness and confidence in bodily signals generally support sexual functioning [14, 15]; it suggests that for women in this subgroup, experiencing less severe restrictive psychopathology, greater confidence in their body may facilitate the experience of sexual desire. This is also supported by the evidence that Cluster 2 showed higher emotional awareness than Cluster 1: thus, a greater ability to connect emotional and body states may contribute to the observed associations between body trusting and need for approval with sexual desire.

Furthermore, sensitivity analyses did not confirm a role of age and BMI as confounding covariates in the present results while depressive symptoms were negatively associated with sexual desire only in cluster 2; this is partially in line with the literature showing a limited association between these variables regardless of ED diagnosis [56, 57]. On the other hand, the inclusion of depressive symptoms did not improve the model fit, supporting the predictive role of need for approval and body listening on sexual desire in the ED population. The distinct patterns emerging across the two clusters provide strong evidence for the psychological heterogeneity underlying sexual

desire in women with EDs. The finding that the same psychological constructs (anxious attachment, interoceptive confidence) can relate to sexual desire in opposite directions depending on the subgroup profile underscores the inadequacy of uniform etiological models. This aligns with research identifying distinct psychological or behavioural subtypes within EDs that may have different clinical correlates [7, 58] and expands a wide body of literature outlining the need of a precision psychiatry through individualized treatment approaches. It is important to note that, although diagnostic categories showed predictive power towards cluster membership, significant heterogeneity emerged in the absence of a clear match between specific diagnoses and clusters. Approximately one-third of women with AN were included in Cluster 2, suggesting that a subgroup of them may share psychological characteristics with individuals with BN and BED. This result aligns with the literature showing that individuals with AN who clustered together with those with BN or BED have latent components of impulsivity or interoceptive/interpersonal alterations that may be responsible for the later onset of binge-purging behaviors or illness cross-over. Conversely, patients with BN or BED belonging to cluster 1 show patterns of interoception and attachment more linked to sexual hypofunctioning and this could be valuable in distinguishing subgroups that evolve differently over time [39]. Future studies with longitudinal designs are necessary to explore the value of the present results in improving the characterization and trajectories of EDs. Overall, the present findings support the need for clinicians and researchers to identify clinical and psychological phenotypes and to integrate them with the information derived from the diagnosis to personalize treatment approaches [59].

The multigroup SEM analyses confirmed the differential predictive pathways for anxious attachment and interoceptive confidence across clusters. Notably, the latent construct representing avoidant attachment did not predict sexual desire in each cluster within the final SEM model. While this appears inconsistent with findings highlighting the relevance of avoidant attachment, particularly in AN, and its impact on sexual recovery [11, 39], several factors might contribute. Avoidant attachment might more strongly influence other facets of sexuality not measured here (e.g., intimacy behaviours or relationship satisfaction) or its impact on desire might be statistically overshadowed by anxious attachment or interoceptive confidence within this specific model configuration. In particular, some facets of interoception, namely the awareness of body sensations, the attention toward body feelings or the ability to connect body feelings and emotions, can at least partially overlap with the need of individuals with avoidant attachment to distract from inner signals to down-regulate emotions [60].

Future studies should continue to disentangle the distinct roles of avoidant and anxious attachment dimensions across various sexual outcomes in EDs and are recommended to elucidate the relationship between interoceptive confidence and avoidant attachment.

These findings contribute to understanding the multifaceted application of attachment theory in clinical populations, demonstrating complex pathways linking attachment anxiety to sexual desire. They also extend research on interoception by highlighting the relevance of body trusting for sexual desire and suggesting its effects may change according to the clinical context (e.g., the ED subgroup). The observation of distinct patient profiles has some clinical implications. First, it underscores the necessity of personalized assessment of sexual health in ED treatment, moving beyond diagnostic labels to understand the individual interplay of factors like attachment style and interoceptive functioning, as suggested by Brotto et al. [5] who outlined the need of integrated approaches to improve sexual dysfunction. Second, interventions may need to be tailored, regardless of ED diagnosis. For individuals reflecting Cluster 1, therapy might focus on reducing the inhibitory impact of relational anxiety and potentially aversive body awareness on desire. For those reflecting Cluster 2, the focus might be on improving body trusting to improve sexual desire, while considering the function of sexuality as a possible strategy to manage fear of rejection. Third, these findings support the potential utility of interventions targeting interoception [14] and attachment patterns [39] as add-ons to standard ED treatment to improve sexual well-being, though adaptations based on patient profile may be necessary.

Key strengths of this study include its large, diagnostically diverse clinical sample, the use of validated measures for core psychopathological dimensions, and the application of advanced statistical methods to explore heterogeneity in the real-world clinical population. The focus on the predictive role of interoception and attachment on sexual desire addresses a novel and important area, and future studies may confirm the current model by developing predictive models on larger samples, with the goal of identifying group membership a priori, and then testing the utility by differentiating interventions based on the cluster. Moreover, performing sensitivity analysis on multiple possible covariates significantly strengthened the results, corroborating the validity of the clusters and the choice of predictors. Some limitations should be acknowledged. First, the cross-sectional design prevents causal conclusions. Second, the study focused on sexual desire as the outcome, limiting insights into other domains of sexual function and satisfaction. Third, other facets of interoception and specific components of avoidant attachment style may contribute to

the heterogeneity of sexual desire in EDs, and their role needs to be explored in future studies. Fourth, the use of self-report measures to predict other self-report measures may have introduced susceptibility to common method bias. However, it is important to note that self-report assessment currently represents the gold-standard method for the variables considered in this study (interoception, adult attachment style, and sexual desire). Furthermore, the instruments used considerably mitigated the risk of bias, both using questionnaires with high levels of psychometric validity and through the statistical analyses employed. In particular, the latent variable modeling helped reduce measurement error by capturing the shared variance across multiple indicators. Finally, with respect to the potential presence of outliers and non-normality, methodological precautions were taken, such as the use of the TLE technique and the Huber-White robust estimator.

Future research should employ longitudinal designs to clarify causal pathways and track changes during treatment. Incorporating behavioural or physiological measures of interoception and sexual response would strengthen findings, while examining the full spectrum of sexual functioning and satisfaction as outcomes is needed. Finally, developing and testing interventions tailored to the distinct psychological profiles identified here represents an important step towards improving sexual health outcomes for individuals recovering from EDs.

Conclusions

This study provides robust evidence of heterogeneity in the psychological factors associated with sexual desire among women with EDs, as supported by the combination of a mixture regression approach, subsequent multigroup SEM confirmation, and the demonstration of measurement invariance across clusters. Two distinct subgroups emerged, characterized by opposite relationships between need for approval, body trusting, and sexual desire. These findings underscore the importance of person-centered approaches in both research and clinical practice, recognizing that the interplay between anxious attachment and interoceptive confidence shapes sexual desire differently across individuals with EDs. Addressing these psychological dimensions may be crucial for fostering sexual well-being and quality of life alongside recovery from EDs.

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Author contributions

Alessio Maria Monteleone designed the study. Emanuele Cassioli conducted the statistical analyses. Eugenia Barone wrote the first draft of the manuscript. Eleonora Rossi contributed to writing and revising the manuscript. All authors contributed to data interpretation, critically revised the manuscript, and approved the final version.

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Availability of data and materials

The datasets generated and/or analyzed during the current study are not publicly available due to privacy or ethical restrictions but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study was approved by the Institutional Ethics Committee of "Area Vasta Centro—CEAVC" (reference number: OSS.14.162) and by the University of Campania L. Vanvitelli Ethic Committee (reference number: 0015736/i). All participants provided written informed consent. The study was conducted in accordance with the Declaration of Helsinki.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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