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ORIGINAL ARTICLE

Body image disturbance in binge eating disorder: a comparison of obese patients with and without binge eating disorder regarding the cognitive, behavioral and perceptual component of body image

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Abstract Whereas the manifestation of body image disturbance in binge eating disorder (BED) has been intensively investigated concerning the cognitive–affective component, with regard to the behavioral and the perceptual components of body image disturbance in BED, research is limited and results are inconsistent. Therefore, the present study assessed body image disturbance in BED with respect to the different components of body image in a sample of obese females ($n = 31$) with BED compared to obese females without an eating disorder ($n = 28$). The Eating Disorder Inventory-2, the Eating Disorder Examination-Questionnaire, the Body Image Avoidance Questionnaire and the Body Checking Questionnaire as well as a Digital Photo Distortion Technique based on a picture of each participant taken under standardized conditions were employed. Using two-sample t tests, we found that the participants with BED displayed significantly greater impairments concerning the cognitive–affective component of body image than the control group. Concerning the behavioral component, participants with BED reported more body checking and avoidance behavior than the controls, but group differences failed to reach significance after the Bonferroni corrections. Regarding the perceptual component, a significant group difference was found for the perceived "ideal" figure, with the individuals suffering from BED displaying a greater wish for a slimmer ideal figure than the control group. These results support the assumption that body image disturbance is a relevant factor in BED, similar to other eating disorders.

Keywords Binge eating disorder · Body image disturbance · Obesity · Digital photo distortion technique

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Introduction

The recently published 5th revision of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) [1] includes binge eating disorder (BED) for the first time as a diagnostic category in the Eating Disorders section. According to the criteria, which are basically in line with the former research criteria of the DSM-IV-TR [2], BED is characterized by recurring episodes of binge eating over the course of at least 3 months with one binge episode on average per week (DSM-IV-TR: duration of 6 months with two binge episodes per week), in which a large amount of food is consumed in a distinct amount of time, often accompanied by a feeling of loss of control [1]. To measure severity of the disorder, the DSM-5 proposes binge eating frequency as a specifying criterion [1]. In contrast to other prominent eating disorders, such as Anorexia nervosa (AN) or Bulimia nervosa (BN), no regular inappropriate compensatory behaviors are undertaken to avoid weight gain, e.g., self-induced vomiting, abuse of laxatives or excessive sport or exercise. Binge eating is often associated with eating quickly and to the point of feeling uncomfortably full, along with feelings of disgust and shame, leading to the individual mostly eating alone [1]. As a consequence of

the excessive food intake, the most frequent comorbidity in BED is obesity, with about 40–70 % of people with BED also suffering from severe overweight [3–5]. Whereas in the diagnostic criteria for AN and BN, body image disturbance is a required criterion for diagnosis, it is not included in the criteria for BED. However, there is growing evidence that body image disturbance might be characteristic for BED as well [e.g., 6–8].

In body image research in AN and BN, a distinction is made between three components of body image disturbance [9]: The cognitive–affective component includes overvaluation of weight and shape as well as body dissatisfaction, with individuals who suffer from AN and BN being more dissatisfied with their own bodies and displaying weight and shape concerns to a higher degree than healthy controls [10, 11]. The behavioral component consists of body-related checking and avoidance behavior, for example, frequent pinching of certain body parts, and avoiding activities with an enhanced focus on the body such as swimming, dancing, etc. Studies of AN and BN have found that patients show a higher degree of body checking behavior [12, 13] and avoidance behavior [14] compared to individuals without an eating disorder. The perceptual component comprises a distorted mental image of one's own body [15]. Whereas healthy persons seem to slightly underestimate their own body dimensions [16], persons with AN and BN rather tend to overestimate them [15, 17].

Unlike research concerning AN and BN, only a limited number of studies have addressed body image disturbance in BED. It has been shown that overvaluation of weight and shape seems to occur to a comparable degree in BED as in AN and BN [e.g., 18, 19]. Even after controlling for the extent of depression and body mass index, individuals with BED and BN did not significantly differ regarding their weight and shape concerns [20, 21]. When comparing obese persons with BED to individuals with obesity but without an eating disorder, a number of studies reported significantly higher weight and shape concerns in obese persons with BED [19, 22–25]. A stronger overvaluation of shape and weight also seems to be associated with a more pronounced eating disorder pathology in general as well as with higher levels of depression in BED and is shown to act as a mediator between weight bias internalization and self-esteem [21, 26].

In contrast, regarding dissatisfaction with one's own body, obese individuals with BED show a similar degree of body discontent to patients suffering from BN, but also to obese persons without BED, although they are more dissatisfied with their bodies than normal-weight, healthy controls [27]. Body dissatisfaction in obese women with BED also seems to be associated with a higher degree of eating psychopathology and with a stronger influence of socio-cultural factors such as the thinness ideal as proposed by the mass media [28]. However, in one study, potential group differences between obese participants with BED and obese controls regarding body dissatisfaction disappeared when depression was controlled for [29]. Accordingly, depressiveness seemed to be a confounding variable, which also might be associated with body dissatisfaction and warrants consideration.

To date, only two studies have examined the behavioral component of body image disturbance in BED [30, 31]. The first of these found high levels of body checking and avoidance behavior in overweight participants with BED, which were also associated with an overvaluation of shape and weight [30]. However, as the authors did not compare the BED group to any kind of control group, it is difficult to evaluate whether the higher degree of body checking and body avoidance was related to the eating disorder pathology itself or to being overweight. In the second study, Legenbauer et al. [31] did not find any significant differences between obese patients with and without BED concerning body-related avoidance behavior. However, as the sample size in their study was small, with $n = 15$ in each group, it remains unclear whether this finding was due to a problem of power.

Similarly, only two studies so far have examined the perceptual component of body image in BED. In the first study, no difference concerning the discrepancy between the actual and the ideal body dimensions was found for participants with BED compared to persons without BED when controlling for BMI [32]. In line with this, the second study [31] did not find significant differences between obese individuals with and without BED in terms of their body size estimations. Again, however, the results need to be interpreted with caution due to the small sample size in the study.

Taken together, previous research consistently indicates a disturbance in the cognitive–affective component of body image in terms of enhanced weight and shape concerns, but not body dissatisfaction, in BED. The number of studies examining the behavioral and perceptual component of body image in BED is very low, and existing studies provide inconsistent results and suffer from methodological problems such as a lack of a control group and low statistical power. As obesity is a frequent comorbidity in individuals with BED [3, 4], and also affects the way in which one's own shape and body dimensions are perceived [33], the aim of the present study was to compare obese individuals with and without BED in terms of the cognitive–affective, behavioral and perceptual component of body image using various self-report questionnaires as well as a Digital Photo Distortion Technique based on a photograph of each participant taken under standardized conditions. As depressiveness and low self-esteem seem to be

frequently associated with BED and the onset of binge eating [26, 34], these variables were also assessed. It was assumed that individuals with BED are significantly more impaired concerning body image, depressiveness, self-esteem and general psychological distress. A further aim of this study was to detect, using exploratory analyses, whether the three components of body image disturbance are associated in BED, and whether depressiveness and low self-esteem correlate with body image disturbance in individuals with BED.

Materials and methods

Sample

In total, $N = 59$ female individuals with obesity took part in the study. Of these, $n = 31$ (OB+/BED+ Group) fulfilled the research criteria for BED according to the former *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV-TR; [2]) and $n = 28$ (OB+/BED− Group) did not fulfill diagnostic criteria for any eating disorder. Participants were recruited at the Mental Health Research and Treatment Center of the Ruhr-University Bochum and via newspaper advertisements. Experienced clinical psychologists assessed diagnoses using the *Structured Clinical Interview for DSM-IV* [*SCID*; 35, 36] and the *Eating Disorder Examination-Interview* [*EDE-I*; 37, 38]. For the OB+/BED+ Group, the complete *Structured Clinical Interview for DSM-IV* [35, 36] was conducted, while the OB+/BED− Group was assessed using the *EDE-I* only. Inclusion criteria for both groups were age between 18 and 55 years and obesity (BMI >30 kg/m^2). No matching procedure was applied; however, the groups did not differ regarding age or BMI. Exclusion criteria were personality disorders, suicidal tendencies, deliberate self-harm behavior, current participation in any other treatment (e.g., psychotherapy or weight loss program) and pregnancy.

For the OB+/BED+ Group, the mean BMI was $M = 35.83$ kg/m^2 (SD = 4.30) and the OB+/BED− Group had a mean BMI of 37.29 kg/m^2 (SD = 4.26). There was no significant difference in BMI between the two groups ($t = -1.308$, $p = 0.196$, $df = 57$). The mean age of the participants with BED was $M = 43.94$ years (SD = 10.06), and the participants without BED had a mean age of $M = 44.11$ years (SD = 11.28). The two groups did not significantly differ in age ($t = -0.062$, $p = 0.951$, $df = 57$). As assessed by the SCID [35, 36], nine participants of the OB+/BED+ Group did not have any comorbid psychiatric disorder, 16 suffered from major depression, two were diagnosed with a comorbid panic disorder, two suffered from social phobia, one had a specific phobia and one suffered from posttraumatic stress disorder. Of the participants with BED, 16 had a higher track school education ("Gymnasium", 12th grade; prerequisite for university entrance), nine had a medium-track school education ("Realschule", 10th grade; focus on general and vocational education), four had a university degree, and two had a lower track school education ("Hauptschule", 10th grade; focus on vocational education).

Self-report questionnaires

From the *Eating Disorder Inventory-2* (EDI-2 [39, 40]) the scales Drive for Thinness and Body Dissatisfaction were applied to operationalize the cognitive–affective component of body image disturbance. The subscale Drive for Thinness (sample item: "I am preoccupied with the desire to be thinner") contains six items and the scale Body Dissatisfaction consists of nine items (sample item: "I feel satisfied with the shape of my body"). Each item is answered on a six-point scale (1 = "never" to 6 = "always"). In the present study, internal consistencies (Cronbach's alpha) were $\alpha = 0.75$ for Drive for Thinness and $\alpha = 0.87$ for Body Dissatisfaction.

To further quantify the cognitive–affective aspect of body image, we applied the *Eating Disorder Examination-Questionnaire* (EDE-Q [41, 42]), using its subscales Weight Concern and Shape Concern, which consist of five and eight items, respectively (Weight Concern sample item: "Over the past 28 days, have you had a strong desire to lose weight?"; Shape Concern sample item: "Over the past 28 days, has your shape influenced how you think about yourself as a person?"). The items are scored on a seven-point scale (0 = "attribute was not present" to 6 = "attribute was present every day"). The internal consistency (Cronbach's alpha) of the scales in the present sample was $\alpha = 0.73$ for the Weight Concern subscale and $\alpha = 0.92$ for the Shape Concern subscale.

To assess the behavioral component of body image, the total score of the *Body Image Avoidance Questionnaire* (BIAQ [14, 43]) was used. On the basis of 19 items, which are scored on a six-point scale (from 0 = "never" to 5 = "always"), body-related avoidance behavior is captured (sample item: "I wear clothes that will divert attention from my weight"). The internal consistency (Cronbach's alpha) was $\alpha = 0.61$ in this study.

In addition, the *Body Checking Questionnaire* (BCQ [12, 44]) was applied, which uses 23 items to assess how often people are involved in body checking behavior (sample item: "I look at others to see how my body size compares to their body size"). The items are each scored on a scale from 1 (= "never") to 5 (= "very often"). The internal consistency (Cronbach's alpha) in the present sample is $\alpha = 0.91$.

To assess depressiveness as a frequent comorbidity, we applied the *Beck Depression Inventory* (BDI [45, 46]). The BDI contains 21 items that are rated on a four-point scale, with higher values indicating a greater level of depression (sample item: "I feel guilty all of the time."). Internal consistency can be considered as good, with Cronbach's alpha $\alpha = 0.88$ in the present study.

Self-esteem was measured with the *Rosenberg Self-Esteem Scale* (RSES; [47, 48]) based on ten items (sample item: "I feel that I have a number of good qualities") that are scored between 0 (= "never applies to me") and 3 (= "always applies to me"). Cronbach's alpha was $\alpha = 0.88$ in our sample.

To assess the general psychopathology, the short version of the *Symptom Checklist 90* [49], the *Symptom Checklist K-9* (SCL K-9; [50]) was applied. It contains nine items to measure the general psychological distress and is highly correlated with the global severity index of the Symptom Checklist 90 [49, 50]. Items (sample item: "During the last seven days how often did you suffer from the feeling that you have to worry too much?") are answered on a five-point scale from 0 (= not at all) to 4 (= extremely). Cronbach's alpha was $\alpha = 0.87$ in this sample.

Digital photo distortion technique

To operationalize the perceptual component of body image disturbance, the *Digital Photo Distortion Technique* [51] was applied. In a first step, a digital photograph of each participant was taken from a frontal perspective in front of white wall, with all individuals wearing the same standardized tight-fitting suit with short arms and legs. Subsequently, the pictures were presented to the participants on a notebook computer screen and the participants were asked to distort the photograph with two arrow keys. By pressing the keys once, the picture was distorted by +0.8 or −0.8 %, respectively. The participants were asked to distort the photograph according to three instructions: what they thought they actually look like ("actual body dimensions"), what they felt they look like ("felt body dimensions") and what they would like to look like ("ideal body dimensions"). To avoid anchor effects [52], the initially presented pictures were distorted twice, as 20 % slimmer than the original picture and 20 % bigger, with values of 100 % indicating the original picture. The participants were allowed to adjust the picture as often as they liked. They were able to save the final distortion of the photograph by pressing the enter key. Cronbach's alpha for the three instructions was $\alpha = 0.68$ in the present study. Additionally, the use of distorted photographs allows the calculation of discrepancy scores that cover the differences between the actual and the felt as well as the actual and the ideal body dimensions as additional indicators of the cognitive–affective component of body image disturbance, e.g., dissatisfaction with one's own body (e.g., [17]).

Statistical analysis

The statistical analyses were done using the SPSS 20 software package. To detect group differences, independent samples t tests including Levene's test for homogeneity of variance were calculated for the various questionnaire scores as well as for the mean scores of the three questions and the discrepancy scores of the *Digital Photo Distortion Technique*. We used Bonferroni corrections since all tests were conducted with the same sample. Additionally, we assessed effect sizes according to Cohen [53] to quantify the magnitude of the group differences. Assuming a large-sized effect ($d = 0.80$), an alpha (α) error level of 5 %, two-tailed testing, and a sample size of $N = 59$, the test power is $1 - \beta = 0.85$ and, therefore, sufficient according to Cohen [53]. To further evaluate the relationships between the different components of body image disturbance as well as between body image disturbance and depressiveness and self-esteem, we calculated Pearson moment correlations for the participants of the OB+/BED+ Group.

Results

Self-report questionnaires

Regarding the cognitive–affective component of body image, the group difference was statistically significant for the subscale Drive for Thinness of the EDI-2, with the OB+/BED+ Group reaching higher scores than the OB+/BED− Group. After Bonferroni correction the subscale Body Dissatisfaction did not reveal significant differences between the groups. On the scales Weight Concern and Shape Concern of the EDE-Q, significant group differences were found, with the OB+/BED+ Group scoring higher than the OB+/BED− Group on each scale. For means and standard deviations as well as results of the t tests and effect sizes, see Table 1.

For the behavioral component of body image disturbance, no significant group differences were found for the total scores of the BIAQ and BCQ (see Table 1), after applying Bonferroni correction.

Moreover, regarding self-esteem, significant group differences were detected on the RSES, indicating less self-esteem in patients with BED (see Table 1). The groups did not differ in terms of depressive symptoms as measured by the BDI after the Bonferroni correction. No significant group difference was found concerning general psychological distress as measured by the SCL K-9.

Table 1 Comparison of obese patients with Binge Eating Disorder (BED) and patients with obesity (OB) without BED regarding the self-report questionnaires

	OB+/BED+ Group		OB+/BED− Group		*t* test				
	M	SD	*M*	SD	*t*	*df*	*p*	*p* Bonferroni	*d*
Eating disorder inventory-2									
Drive for thinness	4.55	0.74	3.34	1.04	5.13	57	<0.001	0.014	1.34
Body dissatisfaction	5.37	0.63	4.71	1.10	2.770	42	0.008	0.112	0.73
Eating disorder examination-questionnaire									
Weight concern	3.93	1.04	2.55	1.54	4.071	57	<0.001	0.014	1.05
Shape concern	4.64	1.02	3.03	1.85	4.079	41	<0.001	0.014	1.07
Body image avoidance questionnaire									
Total score	1.81	0.32	1.57	0.37	2.622	57	0.011	0.154	0.69
Body checking questionnaire									
Total score	1.09	0.72	0.72	0.43	2.281	57	0.026	0.364	0.62
Beck depression inventory									
Total score	15.96	8.43	10.03	8.17	2.737	57	0.008	0.112	0.71
Rosenberg self-esteem scale									
Total score	25.84	6.67	31.25	6.60	−3.124	57	0.003	0.042	0.81
Symptom checklist K-9									
Total score	19.51	21.83	13	18.48	2.626	57	0.009	0.126	0.32

M mean score, *SD* standard deviation, *t* *t* score, *df* degree of freedom, *p* probability level, *p Bonferroni* probability level after Bonferroni correction, *d* effect size

Digital photo distortion technique

While group differences concerning the estimations of one's own "actual" and "felt" body dimensions from the Digital Photo Distortion Technique did not reach statistical significance, the estimation of the "ideal" body dimension turned out to be significant, with the OB+/BED+ Group's wish to be thinner being higher than that of the OB+/BED− Group (see Table 2). Discrepancy scores, as an additional measure of the cognitive–affective component, between one's own "actual" and "ideal" as well as between one's own "felt" and "ideal" body dimensions differed significantly between the two groups, with participants with BED displaying higher discrepancy values.

Correlations between the three components of body image disturbance and depressiveness and self-esteem

We found significant correlations within the measures of each component of body image disturbance, but also some significant correlations between the different components

Table 2 Comparison of obese patients with Binge Eating Disorder (BED) and patients with obesity (OB) without BED as assessed by the digital photo distortion technique

	OB+/BED+ Group		OB+/BED− Group		*t* test				
	M	SD	*M*	SD	*t*	*df*	*p*	*p* Bonferroni	*d*
"Actual" body dimensions	1.07	0.13	1.04	0.11	1.155	57	0.253	1.00	0.24
"Felt" body dimensions"	1.05	0.17	1.00	0.13	1.164	57	0.249	1.00	0.33
"Ideal" body dimensions	0.76	0.10	0.84	0.09	−2.885	57	0.006	0.084	0.84
Discrepancy "actual–ideal"	0.31	0.15	0.19	0.12	3.091	57	0.003	0.042	0.88
Discrepancy "felt–ideal"	0.28	0.17	0.16	0.13	3.001	57	0.004	0.056	0.62

M mean score, *SD* standard deviation, *t* *t* score, *df* degree of freedom, *p* probability level, *p Bonferroni* probability level after Bonferroni correction, *d* effect size

Table 3 Pearson correlations of the different components of body image for the participants with binge eating disorder (BED)

	EDI-2		EDE-Q		BIAQ	BCQ	DPDT				
	DT	BD	WC	SC	Total score	Total score	ABD	FBD	IBD	A-I	F-I
Eating disorder inventory-2 (EDI-2)											
Drive for thinness (DT)	1	0.417*	397*	0.487*	0.129	0.394*	0.307	0.134	0.049	0.240	0.107
Body dissatisfaction (BD)	0.417*	1	0.141	0.046	0.412*	0.346	−0.285	−0.160	0.019	−0.265	−0.172
Eating disorder examination-questionnaire (EDE-Q)											
Weight concern (WC)	0.397*	0.141	1	0.774**	0.380*	0.447*	0.193	0.111	−0.187	0.352*	0.220
Shape Concern (SC)	0.487*	0.046	0.774**	1	0.231	0.282	0.263	0.077	−0.241	0.394*	0.217
Body image avoidance questionnaire											
Total Score (BIAQ)	0.129	0.412*	0.380*	0.231	1	0.405*	−0.044	0.055	−0.142	0.055	0.138
Body checking questionnaire											
Total Score (BCQ)	0.394*	0.346	0.447*	0.282	0.405*	1	0.167	0.194	−0.090	0.208	0.247
Digital photo distortion technique (DPDT)											
"Actual" body dimensions (ABD)	0.307	−0.285	0.193	0.263	−0.044	0.167	1	0.789**	0.193	0.758**	0.682**
"Felt" body dimensions (FBD)	0.134	−0.160	0.111	0.077	0.055	0.194	0.789**	1	0.300**	0.499**	0.833**
"Ideal" body dimensions (IBD)	0.049	0.019	−0.187	−0.241	−0.142	−0.090	0.193	0.300**	1	−0.494*	−0.278
Discrepancy "actual"–"ideal" (A–I)	0.240	−0.265	0.352*	0.394*	0.055	0.208	0.758**	0.499*	−0.494*	1	0.789**
Discrepancy "felt"–"ideal" (F–I)	0.107	−0.172	0.220	0.217	0.138	0.247	0.682**	0.833**	−0.278	0.789**	1

*$p < 0.05$, **$p < 0.001$

Table 4 Pearson correlations of the different components of body image with depressiveness and self-esteem for the participants with Binge Eating Disorder (BED)

	EDI-2		EDE-Q		BIAQ	BCQ	DPDT				
	DT	BD	WC	SC	Total score	Total score	ABD	FBD	IBD	A–I	F–I
Beck depression inventory											
Total score	−0.008	0.076	0.240	0.117	0.037	−0.012	−0.071	−0.093	0.022	−0.077	−0.105
Rosenberg self-esteem scale											
Total Score	0.086	−0.020	−0.227	0.020	0.041	0.113	−0.42	−0.030	0.058	−0.076	−0.064

*$p < 0.05$, **$p < 0.001$

(see Table 3). Concerning the cognitive–affective component, the scales Drive for Thinness and Body Dissatisfaction of the EDI-2 correlated significantly with the scales Weight and Shape Concern of the EDE-Q. Furthermore, in terms of the behavioral component, there were significant correlations between the general scores of the BIAQ and BCQ. Moreover, considering the perceptual component of body image, the measures of the Digital Photo Distortion Technique correlated significantly with each other, with the exception of the correlation between the "actual" and the "ideal" body dimensions and the "ideal" with the discrepancy of the "felt-ideal" body dimension. Regarding the correlations between the different components of body image disturbance, the questionnaires assessing the cognitive–affective component correlated significantly with the questionnaires assessing the behavioral component. Body Dissatisfaction and Weight Concern were significantly correlated with the total score of the BIAQ, and Weight Concern and Drive for Thinness correlated significantly with the total score of the BCQ, indicating a relationship between the cognitive–affective and the behavioral component of body image. In addition, we found significant correlations between the subscales Weight and Shape Concern and the discrepancy scores for the "actual" and "ideal" body dimensions, as assessed by the Digital Photo Distortion Technique.

No significant correlations were found for the BDI and the RSES with the different measures of body image disturbance in the OB+/BED+ Group (see Table 4).

Discussion

The aim of the present study was to examine whether the different components of body image disturbance manifest in BED, as they do in other eating disorders such as AN and BN. As obesity is a common comorbidity in BED and is also known to affect the way in which one thinks about and perceives one's own body [3, 4, 33], we compared obese females with BED to equally obese individuals without an eating disorder. Our results support the hypothesis that persons suffering from obesity and BED show greater body image disturbance than obese persons without an eating disorder, which becomes apparent in all components of body image disturbance. Furthermore, we found that the cognitive–affective and the behavioral component of body image disturbance are associated with each other.

Regarding the cognitive–affective component of body image disturbance, obese participants with BED displayed a significantly higher degree of drive for thinness and a greater overvaluation of weight and shape than participants without BED. After the Bonferroni correction, our results did not support the hypothesis that obese individuals with BED suffer from a higher degree of body dissatisfaction than obese individuals without an eating disorder as measured by the subscale Body Dissatisfaction of the EDI. This is in line with previous findings, which reported that individuals with BED show a similar degree of body discontent to obese persons without BED [27, 31, 54, 55]. This finding might be due to the conception of the EDI-2, which was developed for populations suffering from AN and BN, and might, therefore, lack sensitivity to identify body image problems in individuals with obesity [6]. In addition to the subscale Body Dissatisfaction, we used discrepancy scores between the "actual" and "ideal" as well as the "actual" and "felt" body dimensions as assessed by the Digital Photo Distortion Technique to measure body dissatisfaction based on an individual photograph of one's own body. These discrepancy scores were higher in the group with obesity and BED compared to the group without BED, indicating a higher degree of discontent with one's own body size [17]. The application of this method extends the findings of Legenbauer et al. [31], who did not make use of discrepancy scores and did not find any differences concerning body dissatisfaction between the groups. Discrepancy scores based on photographs of one's own body might be a useful addition to self-report measures as the EDI, because they might be more sensitive for body dissatisfaction in obese individuals with BED.

Regarding the behavioral component of body image disturbance, it was found that participants with BED reported more body-related avoidance and checking behavior in comparison to obese participants without BED, but unfortunately, these group differences did not reach statistical significance after the Bonferroni correction. This result is in contrast to the findings of Reas et al. [30] from a study without a control group, which reported body-related avoidance and checking behavior in overweight patients with BED, but did not make use of a control group. However, it is in line with other research [31] that was unable to find significant group differences between obese participants with and without an eating disorder regarding body image avoidance. Again, a possible explanation might lie in the questionnaire conception of the BIAQ and the BCQ: For example, people with obesity might easily agree or disagree with items such as "I wear baggy clothes." [14, 43] or "I suck in my gut to see what it is like when my stomach is completely flat." [12, 44], without this indicating pathological body image avoidance or checking behavior.

Concerning the perceptual component of body image, assessed using a distortable photograph of one's own body, the group difference in the estimations of one's own "ideal" body was significant, with the participants with BED showing a greater wish to be thinner than the participants without BED in relation to their body as depicted in the photograph. This is in contrast to previous studies, which did not find any differences concerning the perceptual component of body image disturbance in BED [31, 32]. Legenbauer et al. [31] also applied the DPDT, but did not show differences between obese females with BED and those without BED concerning the perceptual component, which might be due to the smaller sample size of their study. In the present study, with respect to the estimations of the "actual" and "felt" body dimensions, both groups estimated their "actual" and "felt" figure rather accurately and displayed a near realistic perception of their body, without over- or underestimating their body dimensions. This result is in contrast to previous findings concerning the other eating disorders [15–17], which showed that while patients with AN and BN tend to overestimate their "actual" and "felt" body dimensions, healthy controls slightly underestimate them. It might be assumed that obese persons perceive their actual and their felt body image rather realistically, but might have a notion of their "ideal" figure as considerably slimmer, which is in line with findings in other eating disorders [56]. As the participants with BED also had significantly lower self-esteem than those without an eating disorder, striving for a slimmer figure might be a way to compensate for self-esteem deficits. As Pearl et al. [26] showed, self-esteem and overvaluation of shape and weight contribute to the internalization of weight bias in obese individuals with BED, which might explain the stronger striving for a slimmer ideal in the BED+/OB+ Group. This is further supported by a study by Bautista-Diaz et al. [28], who demonstrated that a higher degree of body dissatisfaction is associated with a stronger extent of the internalization of the thinness ideal, as proposed by advertisements and other mass media.

Regarding the association between the three different components of body image disturbance within the group of participants with BED, we found significant correlations between the cognitive–affective and the behavioral component, indicating that the more pronounced the cognitive–affective impairment of body image was, the more the participants were engaged in body avoidance and checking behavior. Furthermore, there was a correlation between shape and weight concerns and the discrepancy between the "actual" and the "ideal" body image, indicating that greater weight and shape concerns are related to more body dissatisfaction as measured by the Digital Photo Distortion Technique. The associations among the different components of body image are in line with research concerning BN, which found relationships between the questionnaire measures on the cognitive–affective aspects of body image and the discrepancy between "actual" and "ideal" body image [51]. We did not find correlative relationships between depressive symptoms or self-esteem and the different components of body image disturbance in the OB+/BED+ Group. Accordingly, in the present study, depressiveness and self-esteem do not seem to be associated with body image disturbance in individuals with BED, which is consistent with previous studies, which showed that a disturbed body image is still present after controlling for depression and self-esteem in BED [57, 58]. However, studies have shown that low self-esteem is an important predisposing factor for the development of an eating disorder [34, 59] and is often impaired in individuals with BED (e.g., [21, 23]). In addition to low self-esteem, depressiveness also predicts the onset of binge eating [34] and is a frequent comorbidity in BED [60].

The finding of a disturbed body image in BED raises the question of its importance for the development and treatment of the disorder. For AN and BN, research findings support the central role played by body image disturbance in the processes of etiology, maintenance and relapse [61, 62]. There are indications that overvaluation of appearance as well as body dissatisfaction, among other factors, predict the onset of binge eating [63]. Furthermore, the overvaluation of shape and weight has been linked to negative treatment outcome in obese BED sufferers [64]. However, in the case of BED, this link can merely be assumed, as longitudinal research on this topic is still not sufficient, and it remains unclear which component of body image is a reliable predictor of BED and eating disorders in general.

Besides the lack of knowledge regarding the development and maintenance of BED, treatment for BED is not yet sufficiently successful [65]. Focusing on reducing the overvaluation of shape and weight might be starting points in the treatment of body image disturbance in BED, especially since weight and shape concerns have been shown to mediate the abstinence of binge eating at post-treatment following cognitive–behavioral therapy [64]. However, while previous research in AN and BN demonstrated that checking and avoidance behavior can be reduced by means of body image therapy which incorporates exposure techniques [56, 66], to date, no study analyzing the effectiveness of such interventions on the behavioral component of body image in BED has been published. Helping obese individuals to develop a realistic ideal body shape might be helpful in influencing the perceptual component of body image. Previous studies with patients suffering from eating disorders support the application of interventions which aim to reduce body image disturbance, e.g., using mirror exposure to reduce the negative evaluation of one's own figure and shape [56]. To our knowledge, no randomized-control trial has yet evaluated the effect of exposure therapy in BED.

While this study has implications concerning the understanding of the various facets of a disturbed body image in BED, it also has some limitations that need to be considered when interpreting the results. Regarding the groups that were used in the evaluation study, the participants in both groups were clearly obese, with an average BMI of more than 35 kg/m^2. Since Dingemans and Van Furth [67] showed that obese participants with BED suffer from a greater extent of weight concerns and more frequent binge eating than non-obese patients with BED, it might be helpful to replicate this study with groups of non-obese patients suffering from BED and normal-weight healthy controls to gain an understanding of the extent to which obesity plays a role in the magnitude of body image disturbance in BED. Unfortunately, we did not systematically collect information about the flow of participants through the study, i.e., how many participants were contacted, were invited for diagnostic interviews, were excluded from the study or refused participation. Accordingly, selection effects may not have been registered. A further limitation of this study was that education level or mental comorbidities were not assessed for the control group. Comorbidity with a mental disorder was not an exclusion criterion, but influences from possibly existing psychiatric comorbidities cannot be excluded, so the groups might have differed concerning comorbid mental disorders, which might also have had an effect on the results. However, since the BDI and the SCL K-9 revealed no significant differences between the groups, depressiveness and general psychological distress seemed to be comparable in both groups. In contrast to other studies on this subject, such as that by Legenbauer et al. [31], the sample in the present study consisted of individuals who were not current patients of inpatient treatment centers, but were recruited in an outpatient treatment center and via newspaper advertisements. Since comorbidities of the control group are unclear in this study, group differences may have resulted from selection effects. To validate that group differences were not solely due to possible mental comorbidities of the OB+/BED+ Group, it might be useful to replicate this study and compare inpatient with outpatient groups as well. Furthermore, when interpreting the data, the rather small sample size of the current study should be considered, which resulted in low power to detect medium-sized effects ($1 - \beta = 0.47$). Therefore, non-significant group differences in our study should be interpreted with caution. Nonetheless, a sample size of at least $n = 20$ subjects per cell is considered adequate to reduce the risk of false-positive results [68].

In sum, the findings of this study suggest that although it is not included in the latest diagnostic criteria for BED, body image disturbance is a symptom of BED that does not appear to be attributable merely to the state of being obese. Although the severity rating according to the DSM-5 is based on binge eating frequency, our study supports the consideration of at least the cognitive–affective component of body image disturbance when diagnosing BED. This is in line with other research showing that using overvaluation of shape and weight as a diagnostic specifier provides stronger information about eating disorder psychopathology than the proposed severity rating [69]. Furthermore, body image disturbance should be taken into consideration when treating the disorder, and interventions targeting the various aspects of body image disturbance might be a promising avenue for treatment.

Compliance with ethical standards

Conflict of interest There is no conflict of interest to be disclosed on this paper.

Ethical approval The study was approved of by the ethic commission of the Ruhr-University, Bochum.

Informed consent All participants have given informed consent.

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