The Comorbidity of Personality Disorders in Eating Disorders: A Meta-Analysis

Monica Martinussen, PhD[1], Oddgeir Friborg, PhD[2,3], Phöbe Schmierer, PhD[4], Sabine Kaiser, MA[1], Karl Tore Øvergård, MA[2], Anna-Lena Neunhoeffer, MA[2], Egil W. Martinsen, PhD[5] and Jan H. Rosenvinge, PhD[2]

[1]Regional Center for Child and Youth Mental Health and Child Welfare, UiT The Arctic University of Norway, Tromsø, Norway.

[2]Department of Psychology, UiT The Arctic University of Norway, Tromsø, Norway.

[3]Department of Psychiatric Research, University Hospital of North Norway, Tromsø, Norway.

[4]Central Institute of Mental Health, University of Heidelberg, Mannheim, Germany.

[5]Division of Mental Health and Addiction, Oslo University Hospital and Department of Clinical Medicine, University of Oslo, Oslo, Norway.

Correspondence concerning this article should be addressed to Monica Martinussen, RKBU-Nord, UiT The Arctic University of Norway, N-9037 Tromsø, Norway. E-mail: monica.martinussen@uit.no

Author Note

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Abstract

Purpose: The present meta-analysis summarized the proportion of comorbid personality disorders (PDs) in patients with anorexia (AN) and bulimia nervosa (BN), respectively, and examined possible moderating variables.

Methods: A search of the databases *PsychINFO, Embase,* and *Medline* for the period 1980 – 2016 identified 87 studies from 18 different countries.

Results: The mean proportion of PDs among patients with any type of eating disorder (ED) was .52 compared to .09 in healthy controls. There were no statistically significant differences between AN (.49) and BN (.54) in proportions of any PD or PD clusters except for obsessive compulsive PD (.23 vs .12 in AN and BN respectively).

Conclusions: Both ED diagnoses had a similar comorbidity profile with a high prevalence of borderline and avoidant PDs. Moderator analyses conducted for any ED and any PD yielded significant differences for diagnostic systems with respect to EDs, method for assessing PD as well as patient weight and age.

Keywords: personality disorders, anorexia nervosa, bulimia nervosa, meta-analysis, comorbidity

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Eating disorders (EDs), notably anorexia (AN) and bulimia nervosa (BN), are characterized by self-inflicted weight loss and recurrent episodes of bingeing and purging, respectively. An irrational overvaluation of the importance of controlling food, weight, and body shape represent the specific clinical features [1]. Severe EDs impair quality of life and interpersonal relations [2], and increase the number of productive years lost to disability [3]. The standardized mortality rate is about five times higher than in the general population [4,5], and it takes six to nine years before 70% of the patients no longer meet the diagnostic criteria for an ED [6,7].

Comorbid personality disorders (PDs) are frequently encountered in the treatment of EDs, and may become as protracted and impairing as the EDs. Previous studies [8-10] show that a comorbid borderline, avoidant, or obsessive-compulsive PD may worsen the long-term treatment-outcome of EDs. Moreover, a comorbid PD may complicate treatment challenges by increasing the risk of premature treatment termination due to a fragile therapeutic alliance [9,11], prolonging treatment for non-therapeutic reasons [12-14] or resulting in insufficient focus on alleviating ED-symptoms due to the need to address the PD. However, there are inconsistent findings from studies [15,16] and reviews [17,18] as to whether a concurrent PD predicts a poor outcome of an ED, whether PDs improve at the same rate as the ED or tend to persist after the alleviation of ED symptoms [19-22].

In order to develop and examine comprehensive treatment models in terms of their cost-effectiveness, ability to overcome treatment challenges, and to prevent an unfavourable ED outcome, it is essential to determine how frequently or likely comorbid PDs are expected to appear in EDs. Research to date has shown that a comorbid PD among ED patients may be rather common, yet with large variations in the comorbid proportions, ranging from 27-93%

across all PDs. However, 2-50% of the variation in comorbid borderline PD seems related to heterogeneity in samples, with higher PD proportions among inpatients compared to outpatients or community samples [23-25], and methods for generating PD diagnoses (e.g., higher PD proportions when using self-report instruments compared to clinical interviews) [26-29].

In contrast to qualitative reviews [25], meta-analyses provide proportion estimates, and thereby a more precise summation of the field. In addition, moderator analyses may identify variables explaining the true variation between studies. A moderator of particular interest is age of onset of an ED. While a higher age of onset is related to a lower proportion of PD [30], an early teenage onset is related to more severe general psychopathology [22], that may impair a normal personality development.

Three meta-analyses have addressed the comorbidity of EDs and PDs, comprising 17 studies from 1995 to 2004 [23], 19 studies from 1989 to 1997 [31], and 28 studies from 1983 to 1998 [29]. These studies yielded an overall mean proportion of PDs ranging between .19-.50 for AN and .25-.59 for BN. The only study [29] providing confidence intervals showed large and overlapping intervals for the comorbidity proportions, and hence no statistically significant difference between the mean PD proportions of AN (.50) and BN (.59). All the three studies report an equal proportion (.18) of cluster A PDs for AN and BN, respectively, and higher proportions of cluster B disorders for BN (.27) compared to AN (.19). Cluster C PDs were more prevalent in AN (.46) than in BN (.35) in two of the studies, while the study by Rosenvinge et al. [29] found negligible differences (i.e., .45 and .44, respectively). The latter study did not report estimates for specific PD diagnoses in contrast to the other two meta-analyses [31,23]. These indicated that the avoidant PD was prevalent in both AN and BN (.35 and .25, respectively). The obsessive-compulsive PD was more prevalent in AN (.26) than in BN (.17), while the opposite was the case for the cluster B borderline PDs (.36

and .29, respectively). Moderator analyses, conducted in the Rosenvinge et al. [29] study, found higher PD proportions in studies using self-report instruments rather than structured clinical interviews, and in inpatients compared with outpatient samples. However, these analyses were limited to PD cluster levels. Similar analyses were not conducted at all in the other two meta-analyses, and all studies failed to include a healthy comparison group.

In the current meta-analysis we included a healthy comparison group and the largest number of studies to date. As such we were able to overcome limitations of previous meta-analyses, and to test the impact of several moderator variables such as age, age of ED onset, and BMI on PD comorbidity. Finally, a larger pool of studies could facilitate discussions about the theoretical and clinical implications of how clusters and specific PD diagnoses are distributed across the two ED diagnoses AN and BN.

Method

Search Strategy

PsychINFO, Embase, and Medline were searched for empirical studies published in English and German between January 1980 and January 2016, using the following search terms: “eating disorder(s)” or “anorexia” or “bulimia" and “personality disorder(s)” and “comorbidity”. Using this search strategy, a total of 1168 articles were located.

An additional sample of 62 articles were found in a predecessor of OVID (K = 19), and in the reference lists of six meta-analyses and review articles (K = 43) [23,32,33,29,25,18].

This study was undertaken as part of a project of meta-analytic investigations into the comorbidity between PDs and several symptom disorders, from which papers have been published on anxiety disorders [34], mood disorders [35], and binge eating /eating disorder

NOS [36], respectively. A total of 17 studies were found during the search for papers in relation to the mood and anxiety disorder projects, leading to a total of 1247 articles.

Study Selection

To be included in the analysis articles had to be (1) empirical studies (2) published between 1980 and January 2016, (3) in German or English, with (4) patients of at least 18 years of age, with (5) a primary diagnosis of an ED. In addition, the study had to report (6) diagnostic information about the proportion of comorbid personality disorders. Reading the title and the abstract of the 1247 articles, 1091 papers were removed because patients had been diagnosed with another axis I diagnosis than an ED, or with a comorbid substance-use disorder in addition to the ED, or because the participants had recovered from their ED. Thus, 156 papers remained. An additional 69 articles were removed for various reasons, including sample overlap (K = 20; the most recent and complete article was selected), failure to report the proportion of PDs or statistics that could be converted into proportions (K = 32), studies that had PDs as an inclusion criteria (K = 9) or subjects below 18 years of age (K = 1).

A total of 87 studies comprised the final database, and of these, 25 studies reported information on AN and 32 on BN. The list of included studies and an overview table (A1) are both available from the first author.

Data Extraction

The following variables were coded: year and country of publication, type of ED and PD diagnosis, comorbid events of PD (the proportion of the sample having eating disorders, total and for different sub-types of EDs), sample size, percentage of female participants in the sample. Moderator variables included average age and age of onset, type of sample (inpatient, outpatient or recruited), diagnostic system (i.e., DSM-III, DSM-III-R, DSM-IV,

ICD-9 or ICD10), method for diagnosing PD (interview, self-report questionnaire or clinical assessment), rater blind to the ED diagnosis (yes/no), and weight (BMI and weight classification; underweight, normal, overweight).

Coding and Estimation of Coder Reliability

Coding was performed by three graduate students in psychology, who were trained and supervised by the first, second, and last author. Further details on the estimation of coder reliability may be found in Friborg et al. [36].

Statistical Analyses

A meta-analysis was conducted using the Comprehensive Meta-Analysis V3 program [37]. SPSS (v 23.0) was used for descriptive statistical analyses. The mean weighted event rate (number of PD cases/sample size) was used as an effect size measure. A random effects model was estimated for all meta-analysis calculations as this model assumes effect sizes in a population not to be constant, and that other factors than sampling error can contribute to the observed variation in effect sizes (for example, study design, patient characteristics and measurement methodology) [38]. Studies were weighted by the inverse of the variance components comprised of both random variation (sampling error) and variation between studies [39], resulting in more equal weights between the studies compared to weights assigned when using the fixed effect model. To examine variation between studies, a *Q*-statistic was calculated [40] in addition to I^2 (percentage of observed variance that is real) [39]. A significant result indicates heterogeneity and the need to further examine moderators that may explain the true variance between studies. The analyses were conducted separately for AN combined (anorexia nervosa, anorexia nervosa restrictive type, and bulimic type), for BN (purging and non-purging subtype), and for any type of eating disorder. The category

"any type of eating disorder" included AN, BN, binge-eating disorders, eating disorders not otherwise specified (EDNOS), in addition to eating disorders in general where the sub-type was not reported in the article or reported for BN and AN combined. To ensure independent effect sizes, the study was used as unit of analysis, and multiple effect sizes from a study were combined before the meta-analysis calculations were conducted when needed. Some articles reported the proportion of PDs in healthy controls, and these studies were combined for comparison purposes.

Moderator variables were analyzed if at least three studies were available for each subgroup. Categorical variables were examined by comparing groups with a mixed effects analysis, which uses a random effects model to combine studies within each subgroup and a fixed effect model across subgroups. The BMI was infrequently reported, and thus the three categories underweight, normal, and overweight were used in the moderator analyses. Continuous moderators (age and age of onset) were analyzed using meta-regression with age and age of onset as independent variables and the logit event rate as the dependent variable. The regression parameters were estimated using a random effects model with full maximum likelihood estimation [39]. As the CMA-program performs meta-regression on logit event rates instead of event rates directly, the results have to be transformed back (anti-log) for interpretation purposes. Meta-regression was conducted for the combined category of eating disorders and for any type of personality disorders. Only significant individual moderators were included in the meta-regression to ensure a sufficient sample of studies. Categorical moderators were dummy-coded before entered in the meta-regression analysis. For the moderators weight, age, and age of onset, the analyses could be based on sub-groups from a study if different weight and age groups were reported separately.

Results

Sample Characteristics

A total of 87 published studies were included with a mean publication year of 1998 (*SD* = 6.5). The studies were conducted in 18 different countries. The largest group consisted of American studies (46%), followed by UK (9%), and German studies (7%). A total of 79% studies included only women, whereas the rest had a small proportion of men, and one study included men only. The mean age was 27.3 years (*SD* = 6.6), and the mean age of onset was18.2 years (*SD* = 1.8).

Comorbidity of PDs for any ED and Healthy Controls

Meta-analysis results for any type of ED and healthy controls are presented in Table 1. The mean proportion of any PD was .52 in any EDs, and significantly different from the PD rate (.09) in healthy controls due to non-overlapping confidence intervals. For the three clusters, the mean PD proportion increased from .12 (cluster A), to .28 (cluster B), and to .38 (cluster C) for any ED, and were significantly larger than the proportions found in healthy controls (.02, .04, and .08, respectively). For the specific PDs the proportions of paranoid, borderline, avoidant, dependent, and obsessive compulsive PD were significantly higher for patients with any ED compared to healthy controls. Borderline and avoidant PDs had the highest prevalence in any ED with a mean proportion of .22 and .20, respectively (Table 1). The heterogeneity statistics (*Q*-value) were significant for all analyses in the any ED group, inviting for moderator analysis. The corresponding *Q*-statistics for healthy controls were non-significant except for any PD and dependent PD.

Insert Table 1

Comorbidity for AN and BN

Meta-analysis calculations were also performed for AN and BN separately (Table 2). The mean proportion of any PD was .49 for AN and .54 for BN. The pattern of the estimated mean proportions was similar between AN and BN, and the confidence intervals were overlapping between the two groups. Both disorders yielded high proportions of borderline and avoidant PDs (between .19 - .25). For patients with AN, obsessive compulsive PD was also relatively frequent (.23) and significantly higher than in BN (.12). The calculated *Q*-statistics indicated significant variation among studies for both AN and BN, except for antisocial and narcissistic PDs in AN (Table 2).

Insert Table 2

Moderator Analyses

The heterogeneity statistics indicated significant variation for almost all analyses (Table 1 and 2) indicating a need for examining moderators (Table 3). In order to maximize the number of studies available for moderator analyses, any type of PD was first examined for the combined category of any type of ED. There were no significant differences in PD proportions between the three diagnostic systems (DSM-III, DSM III-R, and DSM-IV) for determining a comorbid PD diagnosis. However, using the DSM-III system for diagnosing EDs resulted in substantially higher mean PD proportions than with DSM-IV (.69 vs .45). The type of assessment for diagnosing PD also revealed significant differences, showing higher proportions for self-report questionnaires (.71), compared to clinical assessments (.45), and interview (.50). Whether or not the clinician was blind to the ED diagnosis did not affect the mean PD proportion. However, the number of studies in each group was relatively small

(K = 3 and K = 4) providing low statistical power. Patient weight was a significant moderator, and samples classified as overweight had generally lower mean PDs compared to normal and underweight samples. Type of sample (outpatient, inpatient, both, and recruited) was not a significant moderator.

Table 3

The moderator analyses were also conducted for AN and BN separately (Table 4). Not all comparisons could be conducted, as many subgroups included fewer than three studies. The assessment method for PDs for BN patients was significant and similar as reported above. Furthermore, BN outpatients and patient samples that were recruited yielded higher comorbidity rates compared to inpatient samples and samples that consisted of both in- and outpatients.

Table 4

The two continuous moderators, mean age and age of onset, had to be examined in a meta-regression model using logit transformed event rates for any PD as the dependent variable. Subgroups of EDs were treated as independent observations for studies which reported mean age and age of onset for different sub groups. The meta-regression was significant for age (K = 84, β_0 = 1.25, β = -0.04, $p < .001$), indicating a decline in PDs with increasing age for any ED. The corresponding analyses for AN and BN resulted in non-significant findings.

Moderator analyses for age of onset with any PD as the dependent variable were not significant for the combined ED category and for AN and BN separately.

To explore the combined effect of multiple moderators, the significant individual predictors from the previous moderator analyses for any ED were included in a meta-regression. The variables were age and three categorical variables (patient weight, diagnostic system for ED, and Method for assessing PD). Each categorical variable consisted of three groups resulting in a total of six dummy variables. The total model with seven variables explained 37% of the between study variance (Table 5). Two of the predictors were significant, including the dummy variables $Weight_{overweight}$ (β = -1.33, $p < .05$) and $MethodPD_{interview}$ (β = -1.39, $p < .05$) indicating lower rates of PDs in samples classified as overweight compared to normal weight, and using interview for diagnosing PDs.

Table 5

Discussion

Summary of Main Results

Personality disorders (PDs) are highly comorbid in both anorexia nervosa (AN) and bulimia nervosa (BN) as more than half of the patients have comorbid PD diagnoses. For both disorders, cluster C PDs are most frequent, followed by clusters B, and A in descending order. For AN, the proportion of cluster C PDs was significantly higher compared with cluster A and B, while there was a non-significant trend towards a higher proportion of cluster B than cluster A PDs. For BN, the clusters B and C PDs were equally prevalent, and both occurred significantly more often than the cluster A PDs.

No difference across the specific cluster A and cluster B diagnoses were observed across AN and BN, but in both groups borderline was the most frequent cluster B specific PD. Within cluster C PDs, a statistically significant difference was detected only for obsessive compulsive PD, which was more prevalent in AN than in BN.

Summary of Moderator Results

We examined several variables as potential moderators. The diagnostic system used to diagnose EDs showed that the DSM-III, DSM-III-R, and the DSM-IV systems in declining order yielded lower comorbid PD estimates.

The use of questionnaires to diagnose PDs revealed higher comorbidity estimates than structured clinical interviews. We also observed a difference in comorbid PDs between the different weight groups, in which the overweight group had a considerably lower rate of PDs than the underweight and normal weight groups. Mean age showed a significant relation with PD comorbidity by being lower in older groups. Age of onset of ED did not explain a significant variation in the proportions of PDs between the studies. The meta-regression model with the predictors patient age and weight, diagnostic system for ED, and assessment method for PD explained a total of 37% of the between study variance.

Models of Understanding and Clinical Implications

The common factor model of understanding the comorbidity between PDs and AN or BN, respectively, posits that a common trait ranging from constriction/perfectionism to impulsivity may result in specific associations between AN and cluster C PDs, notably the obsessive compulsive PD, as well as BN and cluster B, notably the borderline PD [41,1,8,42]. To some extent this prediction was supported in the sense that the obsessive compulsive PD proportion was almost twice as high among AN patients (.22) than among BN patients (.12). There was also a trend towards a higher proportion of a comorbid borderline PD among BN

patients (.25) compared to AN patients (.19). The frequent observation of diagnostic crossovers between EDs [43,44] fits with a common factor model for PDs. Such crossovers are expected to be more likely if the PD pathology underpinning both AN and BN are of a comparable rather than of a dissimilar nature. If EDs share a common underlying personality pathology, we would expect the PD comorbidity differences between AN and BN to be negligible both on the PD clusters and the specific PD levels. Such a prediction was partly supported, as the most frequent specific PD diagnoses across the two ED groups (i.e., the borderline and the avoidant PDs) showed proportions of comparable rates (± .05). Although the differences were somewhat larger on cluster B and C levels (±.10 and ±.07 for AN and BN, respectively), they still were within a comparable window.

For obvious reasons, the present study cannot address whether a comorbid PD complicates the outcome of EDs. Still, the high proportion of PDs in any ED and in AN (i.e., .49), and BN (i.e., .54) bring forward a question of whether comorbid PDs might complicate the treatment of EDs. In particular, the comparable proportions (i.e., of the borderline PD and the obsessive compulsive PD in AN, and between the avoidant and the borderline PDs in BN) may serve to undermine a prototypal picture of these EDs and, rather, to draw the clinician's attention to a broader clinical approach covering a spectrum of obsessionality and impulsivity. In the present study some comorbid PDs (i.e., the schizotypal and the anti-social PDs, and to some extent the schizoid PD) occurred equally rarely in patient samples as in healthy control samples. This finding suggests that the complication model may need modifications. Summarized, assessment of PD comorbidity particularly related to borderline, avoidant, and obsessive compulsive PDs should be a routine in ED treatment.

Strengths and Limitations

This is the largest meta-analytic review of comorbid PDs in EDs to date. The "file-drawer" problem that may often be the case for non-significant psychotherapy trials is less relevant for studies on comorbidity as low or high comorbid prevalences are of equal concern and interest. In addition, we observed considerable heterogeneity in the reported proportions, which normally yields asymmetrical funnel plots compatible with non-publication bias. Moreover, as the comparisons between blinded and non-blinded studies yielded comparable proportion estimates, the validity of the present findings is considered to be good.

Despite the large number of studies included, the moderator analyses were still somewhat restricted, due to scattered missing data prohibiting moderator analyses on subgroup levels, and resulting in meta-regression analyses only for a sub-set of samples and moderator variables.

Given the mean onset of AN in the early teens, it may seem like a limitation to exclude those few studies comprising patients below 18 years of age. In adolescence personality and its deviations are not fully developed. Hence, we would argue that to include the few studies diagnosing PDs among adolescents would yield data with highly disputable validity as well as more heterogeneity in the results, and thus introducing a more serious limitation. The small proportion of men in the primary studies implies that the comorbidity estimates may not be generalizable to men with EDs. However, given the dominance of women with EDs this is a minor limitation.

Conclusions

The present study adds to the literature and the clinical contention that PDs occurs frequently among patients with AN and BN, as has been found with respect to other eating disorder diagnoses [36]. It is noteworthy that the methodological quality of studies has

improved over the years, particularly with respect to the use of standardized methods for determining comorbidity. However, future studies should further improve the methodology by establishing a standardization protocol describing what kind of information all clinical studies should minimally report.

Compliance with Ethical Standards

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Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

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Table 1
Mean Proportions of PD Diagnoses for any Eating Disorders and Comparison Groups

	K	*N*	$\bar{p}_{CI_{.95}}$	Q_{within}	I^2
Eating Disorder					
Any PD	60	5767	.52 .47-.56	603.33***	90.22
Cluster A	27	3874	.12 .07-.17	519.09***	94.99
Paranoid	45	4704	.09 .07-.12	337.25***	86.95
Schizoid	42	4071	.04 .02-.06	285.81***	85.66
Schizotypal	36	3868	.04 .02-.08	484.18***	94.28
Cluster B	29	4965	.28 .22-.34	489.55***	94.28
Antisocial	45	5277	.03 .02-.05	144.89***	69.63
Borderline	71	7893	.22 .19-.26	722.60***	90.31
Histrionic	48	5519	.09 .06-.13	564.81***	91.68
Narcissistic	43	5309	.05 .04-.07	225.41***	81.37
Cluster C	28	4887	.38 .33-.44	326.92***	91.74
Avoidant	54	6268	.20 .17-.24	407.15***	87.02
Dependent	47	5791	.13.10-.18	714.99***	93.57
Obsessive-comp.	57	6435	.16 .13-.19	402.22***	86.07
Comparison group (healthy controls)					
Any PD	11	402	.09 .04-.19	46.47***	78.48
Cluster A	4	117	.02 .01-.07	0.09	0.00
Paranoid	8	334	.04 .02-.07	3.08	0.00
Schizoid	8	335	.02 .01-.04	0.93	0.00
Schizotypal	7	290	.05 .03-.09	4.27	0.00
Cluster B	5	162	.04 .02-.09	1.83	0.00
Antisocial	8	337	.02 .01-.04	2.12	0.00
Borderline	9	368	.03 .02-.06	3.48	0.00
Histrionic	9	346	.06 .03-.11	10.03	20.23
Narcissistic	7	291	.03 .02-.06	0.85	0.00
Cluster C	4	116	.08 .04-.15	1.80	0.00
Avoidant	9	364	.03 .01-.05	2.87	0.00
Dependent	10	1149	.04 .02-.09	24.59**	63.41
Obsessive-comp.	10	403	.08 .05-.11	9.17	1.82

Note. *K* = number of studies, *N* = total sample size, $\bar{p}$ = mean weighted proportion, $CI_{.95}$ = confidence interval, Q_{within} = heterogeneity statistic. A random effects model was used. I^2 = percentage of observed variance that is real.
**$p < .01$, ***$p < .001$.

Table 2. *Mean Proportions of PD Diagnoses for Anorexia Nervosa and Bulimia Nervosa*

	K	*N*	$\bar{p}_{CI_{.95}}$	Q_{within}	I^2
Anorexia nervosa					
Any PD	25	1232	.49 .42-.56	125.87***	80.93
Cluster A	15	710	.13 .07-.22	81.65***	82.85
Paranoid	18	761	.08 .05-.13	49.80***	65.86
Schizoid	17	838	.06 .03-.12	74.72***	78.59
Schizotypal	15	753	.06 .03-.12	66.67***	79.00
Cluster B	17	792	.23 .16-.32	73.55***	78.25
Antisocial	17	844	.03 .02-.05	18.05	11.34
Borderline	23	1194	.19 .15-.25	73.46***	70.05
Histrionic	19	752	.08 .05-.13	43.35**	58.48
Narcissistic	17	826	.07 .05-.11	24.70	35.21
Cluster C	16	761	.43 .33-.54	103.24***	85.47
Avoidant	20	946	.23 .16-.30	100.62***	81.12
Dependent	21	1128	.18. 13-.25	126.03***	84.13
Obsessive-compulsive	24	943	.23 .17-.31	116.96**	80.34
Bulimia nervosa					
Any PD	32	2075	.54 .47-.61	254.10***	87.80
Cluster A	17	1533	.13 .07-.22	258.46***	93.81
Paranoid	26	1846	.10 .06-.14	156.17***	83.99
Schizoid	24	1576	.05 .03-.08	77.59***	70.36
Schizotypal	21	1504	.05 .02-.11	267.34***	92.52
Cluster B	19	1626	.33 .26-.40	139.50***	87.10
Antisocial	25	1647	.05 .03-.07	66.32***	63.81
Borderline	40	2908	.25 .21-.29	206.19***	81.09
Histrionic	28	1718	.15 .10-.22	225.91***	88.05
Narcissistic	24	1604	.06 .04-.10	93.82***	75.49
Cluster C	18	1579	.36 .28-.45	167.59**	89.86
Avoidant	30	1965	.20 .15-.25	167.43**	82.68
Dependent	26	1744	.18 .12-.25	247.59***	89.90
Obsessive-compulsive	31	1965	.12 .09-.16	112.89**	73.42

Note. *K* = number of studies, *N* = total sample size, $\bar{p}$ = mean weighted proportion, $CI_{.95}$ = confidence interval, Q_{within} = heterogeneity statistic. A random effects model was used. I^2 = percentage of observed variance that is real.**$p < .01$, ***$p < .001$.

Table 3

Moderator Analyses Results: Mean Proportions of any Type of Personality Disorder for the Combined Category of Eating Disorders

	K	*N*	$\overline{p}_{CI_{.95}}$	Q_{within}	I^2	$Q_{between}$
Diagnostic system PD						5.11
DSM III	10	1293	.62 $_{.47\text{-}.75}$	153.15***	94.12	
DSM III-R	26	1751	.53 $_{.46\text{-}.60}$	194.14***	87.12	
DSM IV	17	2275	.50 $_{.42\text{-}.58}$	176.76***	90.95	
ICD 10	3	155	.44 $_{.35\text{-}.53}$	2.47	19.27	
Diagnostic system ED						10.48**
DSM III	6	813	.69 $_{.56\text{-}.80}$	22.05**	77.32	
DSM III-R	27	1911	.54 $_{.47\text{-}.62}$	217.54***	88.05	
DSM IV	22	2697	.45 $_{.38\text{-}.52}$	239.53***	91.23	
Method for assessing PD						8.10*
Interview	44	3522	.49 $_{.45\text{-}.56}$	320.78***	86.59	
Questionnaire	8	966	.71 $_{.57\text{-}.82}$	62.97***	88.88	
Clinical	8	1279	.45 $_{.32\text{-}.59}$	121.03***	94.22	
Blind to ED diagnosis						0.04
No	3	829	.44 $_{.24\text{-}.67}$	53.30***	96.18	
Yes	4	318	.47 $_{.36\text{-}.57}$	8.59*	66.13	
Patient weight[a]						13.17**
Underweight	21	777	.52 $_{.43\text{-}.61}$	96.88***	79.36	
Normal weight	20	1475	.58 $_{.48\text{-}.67}$	189.44***	89.97	
Overweight	10	970	.34 $_{.25\text{-}.43}$	64.02***	85.94	
Sample						6.07
Outpatient	20	1479	.50 $_{.42\text{-}.59}$	156.60***	87.87	
Inpatient	18	1562	.60 $_{.49\text{-}.70}$	221.99***	92.34	
Both in- and out	7	717	.45 $_{.35\text{-}.55}$	34.39***	82.55	
Recruited	11	1600	.42 $_{.33\text{-}.53}$	121.13***	91.75	

Note. [a] = based on sub-groups from each study; *k* = number of studies; *N* = total sample size; $\overline{p}$ = mean weighted proportion; $CI_{.95}$ = 95% confidence interval; Q_{within} = heterogeneity statistic; I^2 = percentage of observed variance that is real; $Q_{between}$ = test statistic between groups (mixed effects analysis).
*p < .05. **p < .01***p < .001.

Table 4

Moderator Analyses Results: Mean Proportions of any Type Personality Disorder for Anorexia and Bulimia Nervosa

	Anorexia Nervosa						Bulimia Nervosa					
	K	*N*	$\bar{p}_{CI_{.95}}$	Q_{within}	I^2	$Q_{between}$	*K*	*N*	$\bar{p}_{CI_{.95}}$	Q_{within}	I^2	$Q_{between}$
Diagnostic system PD						2.32						0.54
DSM III	6	388	.64 $_{.44-.80}$	51.35***	90.26		4	483	.59$_{.28-.85}$	85.59***	96.50	
DSM III-R	6	244	.51 $_{.43-.58}$	6.59	24.11		15	720	.58$_{.49-.65}$	56.83***	75.36	
DSM IV	9	426	.45 $_{.32-.59}$	50.50***	84.16		10	757	.53$_{.42-.63}$	63.38***	85.80	
ICD 10	-	-	-	-	-		-	-	-	-	-	
Diagnostic system ED						0.37						1.41
DSM III	-	-	-	-	-		3	364	.62$_{.41-.79}$	15.18**	86.83	
DSM III-R	8	498	.48 $_{.40-.57}$	22.36**	68.70		15	815	.56$_{.45-.66}$	108.95***	87.15	
DSM IV	11	499	.44 $_{.33-.56}$	57.28***	82.54		11	824	.49$_{.39-.59}$	67.54***	85.19	
Method for assessing PD						2.40						11.34**
Interview	17	926	.48$_{.42-.54}$	54.04***	69.70		23	1093	.53 $_{.45-.60}$	109.47***	79.90	
Questionnaire	3	75	.70$_{.40-.89}$	9.55**	79.06		5	472	.73 $_{.59-.83}$	21.08***	81.03	
Clinical	5	310	.41$_{.18-.69}$	56.99***	92.60		4	444	.39$_{.25-.53}$	21.89***	86.30	
Blind to ED diagnosis						1.27						
No	3	269	.36 $_{.20-.56}$	12.72***	84.27		-	-	-	-	-	
Yes	3	143	.48$_{.40-.57}$	1.63	0.00		-	-	-	-	-	
Patient weight[a]	-	-	-	-	-		-	-	-	-	-	

(continued)

Table 4 (continued)
Moderator Analyses Results: Mean Proportions of any Type Personality Disorder for Anorexia and Bulimia Nervosa

	Anorexia Nervosa						Bulimia Nervosa					
	K	*N*	$\bar{p}_{CI_{.95}}$	Q_{within}	I^2	$Q_{between}$	*K*	*N*	$\bar{p}_{CI_{.95}}$	Q_{within}	I^2	$Q_{between}$
Sample						0.73						12.13**
Outpatient	7	340	$.47_{.34\text{-}.60}$	30.00***	80.00		14	691	$.54_{.50\text{-}.58}$	77.19***	83.16	
Inpatient	9	415	$.51_{.35\text{-}67}$	61.93***	87.08		7	384	$.50_{.35\text{-}.65}$	31.15***	80.74	
Both in- and out	5	294	$.43_{.34\text{-}.52}$	8.62	53.59		4	359	$.40_{.31\text{-}.50}$	9.04*	66.82	
Recruited	-	-	-	-			4	383	$.69_{.56\text{-}.79}$	9.04*	66.83	

Note. [a] = too few studies to run moderator analyses; *k* = number of studies; *N* = total sample size; $\bar{p}$ = mean weighted proportion; $CI_{.95}$ = 95% confidence interval; Q_{within} = heterogeneity statistic; I^2 = percentage of observed variance that is real; $Q_{between}$ = test statistic between groups (mixed effects analysis).
*$p < .05$. **$p < .01$. ***$p < .001$.

Table 5

Meta-regression Analysis Results of any Type of Personality Disorder for the Combined Category of Eating Disorders based on a Random Effects Model

	Moderator	β	*Q*-value
	Model		21.95**
	Intercept	0.91	
	Age	0.04	
Weight (ref. = normal weight)	$Weight_{underweight}$	-0.18	4.95
	$Weight_{overweight}$	-1.33*	
Diagnostic System ED (ref. DSM III)	$DiagED_{DSMIII-R}$	-0.53	2.06
	$DiagED_{DSMIV}$	-0.27	
Method for Assessing PD (ref. clin.ass.)	$MethodPD_{interview}$	-1.39*	6.73*
	$MethodPD_{questionnaire}$	-0.78	
K (number of sub samples)		44	
R^2_{analog}		.37	

Note. *Q*-value = test statistic of overall model and between coefficients for dummy variables. R^2_{analog} = proportion of explained total between-study variance by the model.
*$p < .05$. **$p < .01$.

Table A1. *Overview of the Included Studies in the Meta-analysis*

First author	Year	Country	Eating disorder	Mean age	Onset ED (age)	Weight	% women	Sample	Assessment PD	DSM edition PD	DSM edition ED
Ames-Frankel	1992	USA	BN	26.8	19.7	Normal	100	In & Out	Interview	III-R	III-R
Anderluh[a]	2003	England	AN	27.9	16.3	Underweightt	100	In & Out	Interview	Other[1]	IV
			BN	26.7	16.8	Normal					
Becker	2015	USA	BED	44.7	24.87	Overweight	75	Recruited	Interview	IV	IV
Bellodi	1990	Italy	AnyED	-	-	-	-	Outpatients	Interview	III	III
Bolle	2010	Belgium	ANr	25.8	-	-	100	Inpatients	Interview	IV	IV
			ANp								
			BN								
Bossert-Zaudig	1993	Germany	BN	23.1	17.4	Normal	100	Inpatients	Interview	III-R	III-R
Bourke	2006	New Zealand	BN	26.07	-	Underweight	100	Outpatients	Interview	III-R	III-R
Braun	1994	USA	ANr	24.8	-	Underweight	100	Inpatients	Interview	III-R	III-R
			ANbp	24.2	-	Underweight					
			BN	24.4	-	Normal					
Bulik	1995	New Zealand	BN	28.0	19.0	-	100	Outpatients	Interview	III-R	III-R
Carlat	1997	USA	AN	-	19.0	Underweight	0.0	In & Out	Clin Assess	-	IV
			BN	-	19.5	Overweight					
			EDNOS	-	19.1	Overweight					
Caroll[a]	1996	Australia	BN	25.5	-	Normal	100	Outpatients	Interview	IV	IV
Cooper	1988	USA	AN	-	-	-		Recruited	Clin Assess	-	III
			BN	25.7	20.2	Normal	-				
			EDNOS	-	-	-					
Copeland	1995	USA	ANBN	24.0	18.2	-	100	Outpatients	Interview	III	III-R
Diaz-Marsá[a]	2000	Spain	ANr	21.5	-	-	100	Outpatients	Interview	IV	IV
			ANbp	21.5	-	-					
			BN	21.5	-	-					
Dias-Marsá[a]	2011	Spain	ANr	25.3	18.6	- Underweight	100	Outpatients	Interview	IV	IV
			ANbp	24.8	19.3	- Underweight					
			BN	26.6	18.9	- Normal					
Eddy	2002	USA	ANr	22.3	18.9	Underweight	100	In & Out	Interview	III	III-R
			ANbp	22.7	16.2	Underweight					
Fahy	1993	England	BN	23.9	19.3	Normal	100	Outpatients	Interview	Other[1]	III-R
Favoro	2007	Italy	BN	23.6	18.1	-	100	Outpatients	Interview	IV	IV

(continued)

Table A1. *Overview of the Included Studies in the Meta-analysis (continued)*

First author	Year	Country	Eating disorder	Mean age	Onset ED (age)	Weight	% women	Sample	Assessment PD	DSM edition PD	DSM edition ED
Fichter	2004	Germany	BN	25.6	-	Normal	100	Inpatients	Interview	IV	IV
Gartner	1989	USA	ANr	-	-	-		Inpatients	Interview	III-R	III-R
			ANbp	24.0	18.7	-	100				
			BN	-		-					
Gillberg[a]	1995	Sweden	AN	21.0	14.3	-	94	Recruited	Interview	III-R	III-R
Godt	2008	Denmark	AN	23.8	-	Underweight	100	Outpatients	I and Q	III-R	IV
			ANbp	23.8	-	-					
			BN	23.8	-	Normal					
			EDNOS	23.8	-	Normal					
Grilo	1996	USA	AnyED	19.8	-	-	100	Inpatients	Interview	III-R	III-R
Grilo	2002	USA	BED	43.7	-	-	77	Outpatients	Interview	IV	IV
Hay	1991	New Zealand	BN	-	-	-	72	Inpatients	Clin Assess	-	III-R
			EDNOS	-	-	-					
Hertzog	1995	Germany	ANr	25.1	18.4	-	96	In & Out	Interview	-	IV
			ANbp	22.8	15.7	Underweight					
			BN	23.7	16.9	Underweight					
			EDNOS	-	-	Normal					
Hertzog	1992	England	AN	24.5	18.5	Underweight	100	Outpatients	Interview	III	III-R
			ANbp	26.2	17.0	Normal					
			BN	25.5	20.4	Normal					
Inceoglu	2000	Germany	AN	-	-	-	-	Outpatients	Questionnaire	III-R	IV
			BN	-	-						
Johnson	1989	USA	BN	25.0	-	Normal	98	Inpatients	Questionnaire	III	III
Jolanta	2000	Polen	AN	-	-	-	100	In & Out	Interview	IV	III-R
Jordan	2008	New Zealand	AN	20.5	16.0	-	100	Outpatients	Questionnaire	III	III
			BN	25.0	18.5	-					
Karwautz[a]	2002	England	AN	27.7	15.3	Underweight	100	In & Out	Interview	Other[1]	IV
Kennedy	1995	Canada	ANBN	26.9	17.9	Underweight	100	Inpatients	Interview	III-R	III
Kennedy	1990	Canada	ANBN	26.5	19.4	-	100	Inpatients	Questionnaire	III	III-R
Koepp	1993	Germany	ANBN	-	-	-	100	Inpatients	Clin Assess	III-R	III-R

(continued)

Table A1. *Overview of the Included Studies in the Meta-analysis (continued)*

First author	Year	Country	Eating disorder	Mean age	Onset ED (age)	Weight	% women	Sample	Assessment PD	DSM edition PD	DSM edition ED
Kozyk	1998	Australia	BN	-	-	-	100	Outpatients	Interview	III-R	III-R
Larson[a]	2004	Sweden	ANBN	26.1	17.6	Normal	100	Outpatients	Questionnaire	IV	IV
Lilenfeld[a]	1998	USA	AN	24.5	16.3	Normal	100	In & Out	Interview	III-R	III-R
			BN	25.3	16.9	Normal					
Loas	2002	Switzerland/	AN	-	-	-	97	Outpatients	Interview	IV	IV
		France	BN	-	-	-	95				
Maranon	2007	Spain	ANr	-	-	-	100	Outpatients	Interview	IV	IV-TR
			ANbp	-	-	-					
			BN	-	-	-					
			EDNOS	-	-	-					
Matsunaga	1998	Japan	AN	22.4	19.3	Underweight	97	In & Out	Interview	III-R	III-R
			ANbp	24.3	19.3	Underweight					
			BN	22.9	19.2	Normal					
McCann	1991	USA	BN	35.3	-	Overweight	100	Outpatients	Interview	III-R	III-R
McClelland	1991	England	AN	27.0	19.0	-	100	-	Interview	III	III-R
			ANbp	24.4	18.3						
Milos	2003	Switzerland	ANbp	24.9	17.5	Underweight	100	In & Out	Interview	IV	IV
			BN	27.2	17.5	Normal					
			EDNOS	28.1	17.5	Normal					
Monteleone	2005	Italy	BN	24.5	-	Normal	100	Outpatients	Interview	IV	IV
Murakami	2002	Japan	AnyED	21.4	17.9	Underweight	-	Outpatients	Interview	IV	IV
Nagata	2002	Japan	AnyED	24.7	17.1	Underweight	100	Outpatients	Interview	III-R	IV
Norman[a]	1993	USA	AN	25.0	18.0	-	-	Outpatients	Questionnaire	III	III-R
			ANbp	25.0	19.5	-					
			BN	23.7	18.0	-					
Pham-Scottez	2012	France	ANr	24.9	18.4	Underweight	100	Ipatients	Interview	IV	IV
			ANbp	24.9	18.4	Underweight	100	Ipatients	Interview	IV	IV
Picott	2003	USA	BED	41.3	-	Overweight	92	Recruited	Interview	IV	IV
Piran	1988	Canada	ANr	23.4	19.1	Underweight	100	Inpatients	Clin Assess	III	III
			ANbp	23.7	18.5	Underweight					
Powers	1988	USA	BN	28.8	-	Normal	100	Recruited	Interview	III-R	III-R

(continued)

Table A1. *Overview of the Included Studies in the Meta-analysis (continued)*

First author	Year	Country	Eating disorder	Mean age	Onset ED (age)	Weight	% women	Sample	Assessment PD	DSM edition PD	DSM edition ED
Ristvedt	1996	USA	BN	25.6	-	Normal	100	Out & Recruited	Questionnaire	III-R	III-R
Rossiter	1993	USA	BN	29.6	20.3	-	100	Outpatients	Interview	III-R	III-R
Rø	2005	Norway	AN	29.7	16.0	Underweight	100	Inpatients	Interview	IV	IV
			BN	29.7	16.0	Normal					
			EDNOS	29.7	16.0	Normal					
Sansone[a]	1994	USA	Any ED	28.0	-	-	100	In & Out	Interview	III-R	-
Sansone	1989	USA	AnyED	28.8	-	-	100	In & Out	Clin Assess	III	III-R
Schmidt[a]	1990	USA	BN	19.0	-	-	100	Recruited	Interview	III-R	III-R
			EDNOS	19.0	-	-					
Selby	2012	USA	BN	25.3	23.9	-	100	Recruited	Interview	IV	IV
Sexton	1998	USA	ANBN	26.2	-	-	100	Inpatients	Interview	III-R	IV
Skodol	1993	USA	AnyED	-	17.9	-	56	In & Out	Interview	III-R	III-R
Specker	1994	USA	BED	39.2	-	Overweight	100	Recruited	Questionnaire	III-R	IV
Steiger	1996	Canada	BN	26.0	19.4	Normal	100	Outpatients	Interview	III-R	III-R
Steiger[a]	1991	Canada	ANr	29.6	19.0	-	100	Inpatients	Questionnaire	III-R	III-R
			ANbp	29.8	15.3	-					
			BN	27.5	17.5	-					
Stice	2001	USA	BED	40.0	-	Overweight	100	Recruited	Interview	III-R	IV
Striegel-Moore	1999	USA	AN	52.0	-	-	0.0	Inpatients	Clin Assess	-	Other[2]
			BN	45.8	-	-					
			EDNOS	56.7	-	-					
Sunday	1993	USA	BN	-	-	-	100	Inpatients	Interview	III-R	III-R
Sunday	2001	USA	ANr	-	-	-		In & Out	Interview	IV	IV
			ANbp	-	-	-					
			BN	29.2	-	-	100				
Suzuki	1994	Japan	BN	-	19.2	-	100	In & Out	Interview	III-R	III-R
Telch	1998	USA	BED	43.5	18.7	Overweight	100	Recruited	Interview	III-R	IV
Thompson-Brenner	2005	USA	BN	28.5	-	-	100	Outpatients	Clin Assess	IV	IV
Thorton	1997	Australia	AN	-	-	-	100	Inpatients	Interview	III-R	III-R
			BN	-	-	-					
Tozzi	2006	Nord Am & Euro	AnyED	27.9	17.1	Normal	100	In & Out	Interview	IV	IV

(continued)

Table A1. *Overview of the Included Studies in the Meta-analysis (continued)*

First author	Year	Country	Eating disorder	Mean age	Onset ED (age)	Weight	% women	Sample	Assessment PD	DSM edition PD	DSM edition ED
van den Hout	2006	Netherlands	AnyED	-	-	-	-	Inpatients	Interview	-	-
van Hanswijck de Jonge	2003	England	BN	28.1	-	Overweight	100	Outpatients	Interview	IV	IV
			BED	36.9	-	Overweight					
Vize	1995	England	AnyED	24.8	20.1	-	100	In & Out	Questionnaire	III-R	III-R
Waller	1993	England	ANr	-	-	-		Outpatients	Clin Assess	III-R	III-R
			ANbp	-	-	-	100				
			BN	-	-	-					
Wiederman	1997	USA	ANr	26.7	-		100	-	Questionnaire	-	III-R
			ANbp	26.7							
			BN	26.7		-					
Wifley	2000	USA	BED	45.2	-	Overweight	83	Recruited	Interview	III-R	III-R
Wiseman	1999	USA	AnyED	27.1	17.6	-	100	In & Out	Interview	IV	IV
Wonderlich	1990	USA	ANr	21.4	17.0	Underweight	100	Inpatients	Interview	III-R	-
			ANbp	22.9	16.5	Underweight					
			BN	23.4	17.8	Normal					
Yager	1989	USA	ANbp	-	-	-	100	Recruited	Questionnaire	III	III
			BN	24.7	14.9	Normal					
			EDNOS	24.7	14.9	Normal					
Yanovski	1993	USA	BED	36.1	-	Overweight	77	Recruited	Interview	III-R	III-R
Yates	1989	USA	BN	-	-	-	100	Recruited	Questionnaire	III	III-R
Zanarini	1990	USA	BN	26.2	18.3	Normal	100	Outpatients	Interview	III	III
Zeeck	2000	Germany	AN	24.0	17.9	Underweight	88	Inpatients	Interview	Other[1]	Other[1]
Zerbe	1993	USA	AnyED	28.4	-	-	91	Inpatients	Clin Assess	III-R	III-R

Note. ED = eating disorder, PD = personality disorder; AN = anorexia nervosa, BN = bulimia nervosa, ANBN = any type of anorexia nervosa and bulimia nervosa, ANr = anorexia nervosa, restrictive type, ANbp = anorexia nervosa, bulimic type, EDNOS = eating disorder not otherwise specified, BED = binge eating disorder, AnyED = any type of eating disorder; In & Out = inpatients and outpatients, Out & Recruited = outpatients and recruited; Clin Assess = clinical assessment.

[a]Studies which included healthy control groups used in the analyses. [1]ICD-10. [2]ICD-9-CM.