



# A cluster analysis of purging disorder: Validation analyses with eating disorder symptoms, general psychopathology and personality

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## Abstract

**Objectives:** To assess the natural grouping of Purging Disorder (PD) patients based on purging symptomatology and to evaluate the derived classes (a) against each other and (b) to a control group on a range of clinical and psychological measures.

**Method:** Participants included 223 PD women consecutively admitted to a tertiary ED treatment centre and 822 controls. Purging behaviours (self-induced vomiting, laxative and diuretic use) were used as indicators, while the EDI-2 (ED symptoms), the SCL-90-R (general psychopathology), and the TCI-R (personality traits) were used as validators.

**Results:** Three distinct PD clusters emerged: Cluster 1 (only self-induced vomiting), Cluster 2 (self-induced vomiting and laxative use) and Cluster 3 (all purging methods). Significant differences between Cluster 1 and Cluster 3 were found for the EDI-2 drive for thinness and perfectionism subscales, and the TCI-persistence scale. All clusters differed significantly from the controls on all the EDI-2 and the SCL-90-R scales, but findings for the TCI-R scales were less consistent.

**Conclusions:** This study adds to a growing literature on the validity and distinctiveness of PD and provides evidence of dimensional symptom differences amongst PD clusters.

**KEYWORDS**

classification, OSFED, personality, purging disorder, severity indicator

## 1 | INTRODUCTION

Based on DSM-5 diagnostic criteria (APA, 2013), almost 30% of all Eating Disorder (ED) patients are diagnosed as Other Specified Feeding or Eating Disorder (OSFED; Mancuso et al., 2015), a broad heterogeneous mixture of various eating disorder (ED) symptoms. This prevalence used to be higher in DSM-IV (APA, 2000), where the prevalence rate for Eating Disorders Not Otherwise Specified (EDNOS) was often as high as 50% (Fairburn & Cooper, 2011). One of the specific OSFED categories is Purging Disorder (PD), which is characterised by self-induced vomiting, misuse of laxatives or diuretics to control weight or shape, in the absence of binge eating episodes (APA, 2013). In treatment settings, prevalence rates of PD have been found to vary from 3% at an inpatient facility (Dalle Grave & Calugi, 2007) to up to 24% (Binford & le Grange, 2005) in an outpatient ED treatment centre.

In 2017, a meta-analysis of 38 eligible PD studies, revealed that PD occupies a space that falls between Anorexia Nervosa (AN) and Bulimia Nervosa (BN), 'not quite' one or the other (Smith, Crowther, & Lavender, 2017). Empirical classification studies have provided inconsistent results regarding PD as a distinct phenomenon, with some revealing a latent class bearing a resemblance to PD (Striegel-Moore et al., 2005; Swanson et al., 2014), whereas others refute this (Wade, Crosby, & Martin, 2006). However, to date, no study has assessed whether different clusters exist across a clinical PD sample. The current study, therefore, evaluated for the first time the natural grouping of PD patients, according to DSM-5 criteria, and compared these classes to each other and a control group.

### 1.1 | Classification studies of purging disorder

In the PD literature, only a small amount of classification studies has been reported. These studies have generally yielded inconsistent findings regarding the uniqueness of PD, with some studies supporting a latent class resembling PD (Pinheiro, Bulik, Sullivan, & Machado, 2008; Striegel-Moore et al., 2005; Sullivan, Bulik, & Kendler, 1998), whereas others have failed to find such a distinction (Bulik, Sullivan, & Kendler, 2000; Keel et al., 2004; Wade et al., 2006). For instance, Striegel-

### Highlights

- A three-cluster profile was the best fitting solution for the Purging Disorder (PD) data: Cluster 1 (only vomiting), Cluster 2 (vomiting and laxative use) and Cluster 3 (all purging methods).
- All clusters differed significantly from the controls on eating disorder symptoms and general psychopathology, but findings for personality were less consistent.
- There were only a few differences across the clusters, with most differences obtained between Cluster 1 (less severe) and Cluster 3 (most severe).
- Clinicians are encouraged to provide a careful assessment of specific features of PD patients based on the three clusters identified in the current study.

Moore et al. (2005), who assessed data from women with BN symptoms, provided support for a distinct PD group, which was characterised by frequent purging behaviours and negligible bingeing. Similarly, Mitchell et al. (2007), applied latent profile analysis (LPA) in their sample diagnosed with EDNOS, and also revealed a cluster characterised mainly by vomiting and laxative use. Conversely, results from Wade et al. (2006) failed to distinguish between women who purged and binged from women who purged without any associated objectively large binge episodes. Explanations for the inconsistent findings across the comparison and classification studies have centred on the lack of consensus regarding the description of PD and various other methodological differences in samples and indicators included in the different analyses.

### 1.2 | The importance of the severity index in the DSM-5

Researchers have argued that when evaluating the validity of a diagnostic category, such as PD, it is essential to consider both categorical differences in symptom topography as well as dimensional differences in severity (Keel,

Crosby, Hildebrandt, Haedt-Matt, & Gravener, 2013; Koch, Quadflieg, & Fichter, 2013). The DSM-5 (APA, 2013) outlines a severity index for the official ED diagnoses, including AN, BN and Binge Eating Disorder (BED). BN is considered as the ED category mostly resembling PD, given the overlap in purging behaviours and weight criteria (APA, 2013; Riesco et al., 2018). The BN severity index is based on the frequency of inappropriate compensatory behaviours (i.e., self-induced vomiting, laxative use, diuretic use): mild (1–3 episodes per week), moderate (4–7 episodes per week), severe (8–13 episodes per week), and extreme ( $\geq 14$  episodes per week). Clinical relevance of the BN severity specifiers has been obtained from studies assessing both clinical ED (Dakanalis et al., 2017; Dakanalis, Clerici, Riva, & Carra, 2017; Jenkins, Luck, Cardy, & Staniford, 2016) and nonclinical samples (Grilo, Ivezaj, & White, 2015). To our knowledge, no study has yet applied the BN severity specifiers for the purging behaviours in a PD sample and assessed its validity. This is significant as evidence for dimensional differences in PD would provide support for the validity of PD as a distinct diagnostic category.

### 1.3 | Aims of the study

Taken together, the best classification of PD patients using taxometric statistical analyses has not yet been satisfactorily determined. To inform future research for classification systems (i.e., DSM-6) and offer a characterisation of PD that has clinical utility, the current study, therefore, aimed to assess for the first time the clinical significance and diagnostic validity of a large PD sample using cluster analyses.

The aims of the current study were threefold. Firstly, we aimed to explore natural groupings of PD patients on key diagnostic variables measuring the purging profile, including weekly frequency of vomiting, laxatives and diuretic misuse. Secondly, we assessed the validity of the final PD cluster solution, by comparing the derived clusters on a range of validator variables, including sociodemographics, general and ED-related psychopathology and personality. Thirdly, to explore the relevance of the PD clusters to established theoretical dimensional systems, the PD cluster solution was compared to the DSM-5 (APA, 2013) severity index for BN for purging behaviours (i.e., mild, moderate, severe, extreme). BN severity specifiers were chosen for this aim because the DSM-5 (APA, 2013) does not currently provide any specifiers for PD.

The clinical significance of the PD clusters would be evidenced by significant differences between the PD clusters and the control group on the assessed variables. We used the definition of PD currently outlined in the

DSM-5 (APA, 2013) and most commonly used in the literature (e.g., Keel, 2007, 2019; Smith et al., 2017), which includes individuals who have used purging episodes (e.g., self-induced vomiting, laxative and/or diuretic misuse) in the absence of objectively large binge-eating episodes at least once per week, averaged over the past 3 months, to control their weight or shape and undue influence of weight or shape on their self-evaluation.

## 2 | METHOD

### 2.1 | Participants

The sample comprised 223 PD female patients presenting consecutively for treatment to the ED Unit within the Department of Psychiatry at Bellvitge University Hospital (Barcelona, Spain). A sample of female volunteers ( $n = 822$ ) with a body mass index (BMI) between 18.5 and 24.9 kg/m<sup>2</sup>, and no history of an ED were used for comparison purposes. Patients were diagnosed according to DSM-IV-TR criteria (APA, 2000), and diagnoses were re-analysed and re-codified post hoc using DSM-5 criteria (APA, 2013).

Exclusion criteria for all the participants were: (a) being male (due to the low prevalence in PD); and (b) being under 18 or over 50-years old. Furthermore, in the control group, an additional exclusion criterion was having suffered from a lifetime ED. This was assessed using a self-report screening instrument with closed-ended questions addressing core features for the diagnosis of EDs based on DSM-5 criteria (APA, 2000, 2013; e.g., presence and frequency of binge eating episodes, vomits, laxative and diuretics misuse and weight loss, both in the last 3 months and lifetime).

The mean age of the PD sample was 27.3 years ( $SD = 9.7$ ), and the mean age of the control group was 22.52 ( $SD = 5.65$ ). The mean age of onset of the ED was 19.9 years ( $SD = 7.6$ ), and the mean duration of illness was 7.1 years ( $SD = 7.0$ ). The mean value for the weekly frequency for the different purging behaviours was 4.3 ( $SD = 9.9$ ) for vomiting, 3.5 ( $SD = 10.7$ ) for laxative use and 2.7 ( $SD = 9.8$ ) for diuretic use. Table 1 outlines the sociodemographic information for the PD groups obtained in the clustering procedure and the control sample. This table includes both the results of the global comparison between the empirical PD clusters, as well as the pairwise comparison of each cluster versus the control group. All sociodemographic variables differed significantly between the PD clusters and the control group, with the control group being younger, more frequently single, having completed secondary education and being more commonly employed.

TABLE 1 Comparison between the empirical clusters with the control group

	Cluster-1		Cluster-2		Cluster-3		Control		Pairwise comparisons (p)			
	n = 121		n = 55		n = 47		n = 822		C1-controls	C2-controls	C3-controls	
	n	%	n	%	n	%	n	%	p	p	p	
<i>Origin</i>												
Spain	107	88.4%	50	90.9%	44	93.6%	811	98.7%	<.001*	<.001*	.008*	
Immigrant	14	11.6%	5	9.1%	3	6.4%	11	1.3%				
<i>Marital</i>												
Single-widow	100	82.6%	40	72.7%	32	68.1%	744	94.5%	<.001*	<.001*	<.001*	
Married-couple	13	10.7%	11	20.0%	9	19.1%	34	4.1%				
Divorced-separated	8	6.6%	4	7.3%	6	12.8%	11	1.3%				
<i>Education</i>												
Primary	59	48.8%	27	49.1%	17	36.2%	319	36.2%	<.001*	<.001*	<.001*	
Secondary	51	42.1%	23	41.8%	21	44.7%	742	90.3%				
University	11	9.1%	5	9.1%	9	19.1%	70	8.5%				
<i>Occupation</i>												
Unempl.	53	43.8%	31	56.4%	20	42.6%	40	4.9%	<.001*	<.001*	<.001*	
Student	34	28.1%	16	29.1%	21	44.7%	115	14.0%				
Employed	34	28.1%	8	14.5%	6	12.8%	667	81.1%				
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	p	Controls	Controls	
Age	25.66	8.69	27.78	10.51	30.94	10.41	22.52	5.65	.006*	<.001*	<.001*	

\*Significant comparison (.05 level).

## 2.2 | Measures

### 2.2.1 | Eating disorder inventory-2

This multidimensional self-report questionnaire includes 91 items to assess cognitive and behavioural characteristics related to EDs: drive for thinness, body dissatisfaction, bulimia, ineffectiveness, perfectionism, interpersonal distrust, interoceptive awareness, maturity fears, asceticism, impulse regulation, and social insecurity (Garner, 1991; Spanish version: Garner, 1998). A global measure of ED severity can be obtained based on the sum of all the items on the scale. Internal consistency for EDI scales was good to excellent in our sample and ranged from 0.71 for the ascetic subscale to 0.97 for the total scale.

### 2.2.2 | Temperament and character inventory-revised

This self-report questionnaire is designed to evaluate personality traits using 240-items on a five-level Likert scale (Cloninger, 1999; Spanish version: Gutiérrez-Zotes et al., 2004). It is structured on seven primary personality dimensions: four temperamental factors (novelty seeking, harm avoidance, reward dependence and persistence) and three-character dimensions (self-directedness, cooperativeness and self-transcendence). Cronbach's alpha for the temperament and character inventory-revised (TCI-R) in the current study sample was adequate to excellent and ranged from 0.79 for novelty-seeking to 0.90 for harm avoidance.

### 2.2.3 | Symptom checklist-revised (SCL-90-R)

This 90-item self-report questionnaire is widely used for the measurement of psychopathology (Derogatis, 1990; Spanish version: Derogatis, 2002). It is structured on nine first-order dimensions: somatisation, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation and psychoticism. The SCL-90-R also comprises the following summary scales; a positive symptom distress index (PSDI), designed to measure the intensity of symptoms as well as a positive symptom total (PST), which measures self-reported symptoms. The global severity index (GSI) represents the severity of psychopathology symptoms across all domains. Internal consistency for SCL-90-R scales was between good to excellent in our sample and ranged from 0.80 for paranoid ideation to 0.98 to global scales.

## 2.2.4 | Procedure

All ED participants were first assessed during a structured face-to-face interview [for further information, please refer to Fernandez-Aranda & Turon (1998)]. During the interview the clinical data were retrieved based on the SCID-I (First, Spitzer, Gibbon, & Williams, 2002) and from 2015 onwards the SCID-Clinical Version (First, Williams, Karg, & Spitzer, 2015) criteria. ED diagnoses were made using this information. All interviews were carried out by experienced psychologists. Further psychometric data were obtained from the ED patients using the above-mentioned self-report questionnaires. Participants in the control group were recruited from the same university hospital setting to guarantee the equivalence of the geographical origin between study groups. The control group filled in all measures using a self-report questionnaire. The Ethics Committee of our institution approved the current study, and informed consent was obtained from all participants.

## 2.3 | Statistical analysis

Statistical analyses were carried out with SPSS24 for Windows. Empirical groups were explored through a Two-step-cluster procedure using the PD sample ( $n = 223$ ). The indicator variables measured the purging profile: total number of purging episodes, presence of vomiting, laxatives and/or diuretics. The two-step-cluster method allows identifying natural groupings (clusters or classes) within datasets that would otherwise not be apparent. In the first step of the analyses, individuals are pre-clustered according to a sequential clustering approach into small sub-clusters. In contrast, during the second step, these sub-clusters are re-grouped into a final number of clusters according to the agglomerative hierarchical clustering method (the log-likelihood distance and the Schwarz Bayesian Information Criterion are employed in determining the optimal number of clusters, choosing a solution with a reasonably large ratio of Schwarz Bayesian Information Criterion changes and a large ratio of distance measures). The procedure uses the log-likelihood distance measure through a multinomial probability mass function for categorical variables and a standard density function for continuous variables. The algorithm used by the Two-step-cluster has desirable features, which make it different from traditional clustering and latent class techniques (Bacher, 2000): (a) handling of categorical and quantitative variables; (b) automatic selection of the number of clusters-classes (by comparing the values of a model-choice criterion across different grouping solutions) and (c) scalability, which allows analysing large data files by constructing a cluster-features-tree which is used as a summary of the records.

The final model selected in this study was based on clinical judgment and the following statistical criteria (Nylund, Asparouhov, & Muthén, 2007): (a) adequate goodness-of-fit (based on a cohesion and separation index); (b) appropriate clinical interpretability; and (c) sample size for each group to guarantee statistical power. In this study, the Silhouettes coefficient (which estimate the cohesion of the elements within a cluster and the separation between the clusters), was used as a measure of the goodness of the final cluster solution (this coefficient ranges from  $-1$  to  $+1$ ), being the values lower than  $0.30$  interpreted as poor fitting, between  $0.30$  and  $0.50$  as appropriate fitting and higher than  $0.50$  as good fitting (Rousseeuw, 1987).

The validity analysis of the final cluster solution was based on the comparison between the empirical clusters on sociodemographics and ED clinical data as well as the following measures: eating disorder inventory-2 (EDI-2), SCL-90-R and TCI-R. Additionally, empirical clusters were also compared with the control sample. The comparison between the groups was based on chi-square tests ( $\chi^2$ ) for categorical variables and analysis of variance (ANOVA) for quantitative variables. The increase in Type-I error due to multiple statistical comparisons was done with Finner's method, a Familywise error rate step-wise procedure which offers a more robust test than the classical Bonferroni correction (Finner, 1993).

### 3 | RESULTS

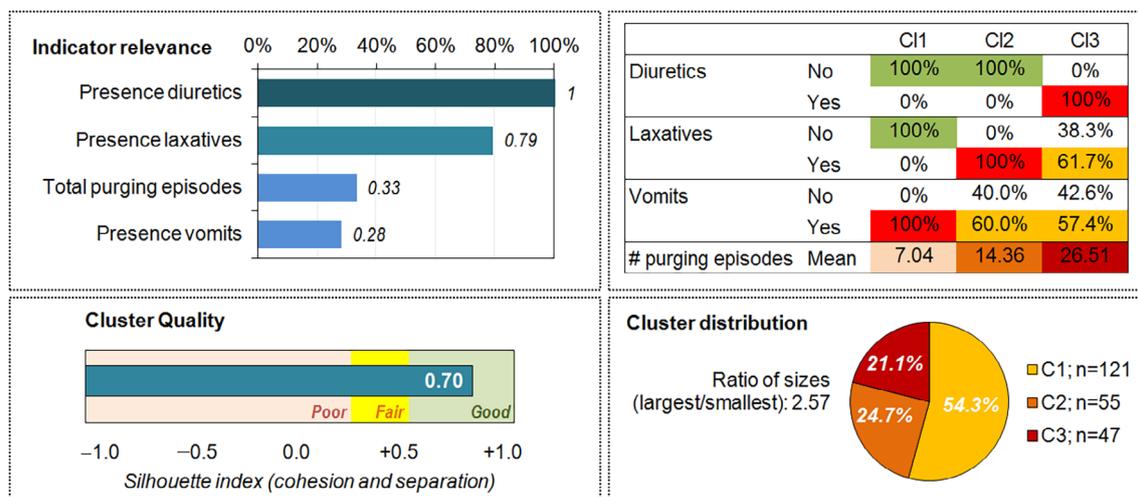
#### 3.1 | Cluster composition

The final three-cluster solution (chosen by the Two-step-cluster procedure and based on the researchers' clinical

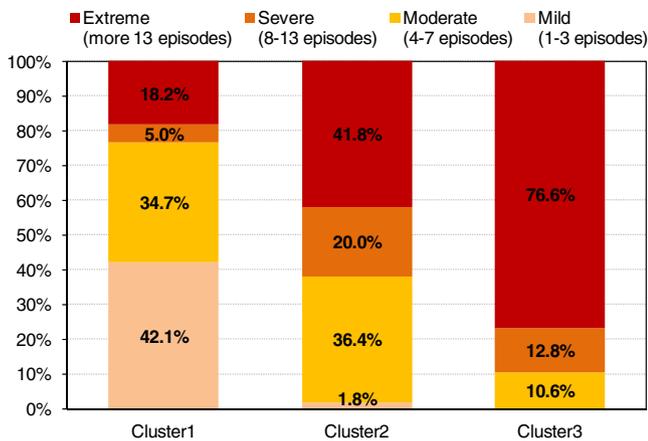
judgement) was selected as being the most optimal classification solution of the  $n = 223$  women who met criteria for PD. This solution obtained a Silhouettes index ( $0.70$ ) in the good range, suggesting adequate evidence of cluster structure in the data. The comparison between the largest cluster size ( $n = 121$ ,  $54.3\%$ ) and the smallest ( $n = 47$ ,  $20.2\%$ ) yielded a ratio of  $2.57$ .

Figure 1 represents the clustering procedure for this three-cluster solution. The first figure contains the bar-graph with the indicators' relevance in the clustering procedure, which reports how well each variable can differentiate between the derived clusters (the higher the importance of the variable, the less likely it is that the variation for the variable between clusters is due to chance and the more likely it is expected to be because of the underlying differences). The indicator variable with the highest statistical, not clinical, contribution into the clustering was the presence of diuretics, followed by the presence of laxatives. The total number of purging episodes and the presence of vomiting achieved lower relevance for the clustering.

The table included in the right panel of Figure 1 contains the centroids for the indicators in the clustering (prevalence for each purging behaviour and mean for the total purging episodes), which summarises the clusters patterns for this set of variables. Cluster 1 included participants who only reported the presence of vomiting (all the participants in the group reported this behaviour) and registered the lowest mean for the total purging episodes (equal to  $7.0$ ). Cluster 2 comprised participants who reported the presence of vomiting (prevalence into the cluster equal to  $60\%$ ) and laxatives (prevalence equal to  $100\%$ ) and the mean for the total purging episodes was  $14.4$ . Cluster 3 consisted of participants who reported the presence of vomiting, laxatives and diuretics (with



**FIGURE 1** Results of the clustering procedure based on the purging profile [Colour figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]



**FIGURE 2** Distribution of the purging severity based on the DSM-5 into the empirical clustering [Colour figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]

prevalences equal to 57.4, 61.7 and 100%), and the mean for the total purging episodes was the highest (equivalent to 26.5).

### 3.2 | Purging severity distribution according to DSM-5 criteria

Figure 2 includes the 100%-stacked bar chart with the distribution of the purging severity classification based on the DSM-5 (APA, 2013) for BN severity criteria into each empirical cluster identified by the Two-step-cluster. Most patients in Cluster 1 were classified in the DSM-5 mild (42.1%) and moderate (34.7%) severity levels. Cluster 2 included patients pertaining to the DSM-5 moderate (36.4%), severe (20.0%) and the extreme level (41.8%). Finally, the majority of patients in Cluster 3 were classified as extreme by the DMS-5 (76.6%).

### 3.3 | Comparison between the empirical clusters

The first block of Table 1 contains the global comparison between the three empirical PD clusters for the sociodemographic variables. Statistical differences emerged for chronological age and occupational status. Concretely, patients in Cluster 1 were significantly younger than patients in Cluster 3. Regarding employment status, when compared to the other two clusters, Cluster 1 included a higher prevalence of employed women, while Cluster 2 included a higher prevalence of students.

Table 2 contains the comparison between the three clusters for the clinical variables of the study. The

comparison between Cluster 1 and Cluster 2 only obtained differences for the mean score in the EDI-2 drive for thinness scale (higher mean for patients in Cluster 2) statistically. Significant differences were obtained for the comparisons between Clusters 1 and 3; patients in Cluster 1, reported a shorter duration of the ED, reported lower scores in EDI-2 drive for thinness and perfectionism scales and lower TCI-R persistence scores. Cluster 2 and 3 differed significantly for age of ED onset, with the oldest age of ED onset being reported for the Cluster 3 patients.

### 3.4 | Comparison between the empirical clusters with a control group

Table 2 also includes the clinical comparison between the empirical clusters and the control group. All clusters obtained significantly higher scores from the control group on all ED symptomatology (EDI-2) and general psychopathological (SCL-90-R) scales, as well as the variables of body composition measuring fat mass, muscle mass and highest ever recorded (maximum) BMI. Furthermore, Cluster 3 presented with a higher current BMI than the control group and Cluster 2 and revealed a higher minimum lifetime BMI than the control group. Regarding the personality profile (TCI-R), Cluster 1 differed statistically from the control group in all the scales. However, no differences were found when comparing Cluster 2 and Cluster 3 to the control group for novelty seeking, persistence and self-transcendence.

## 4 | DISCUSSION

To date, no previous research has employed a taxometric approach to assess whether PD patients can be classified into natural occurring groups. The aim of the current study was, therefore, to use cluster analyses for the first time on a large sample of PD patients, and to assess the clinical significance (comparison to a control group) of the emerging clusters on a range of ED related factors (e.g., EDI-2), general psychopathology (SCL-90-R) and personality traits (TCI-R). Our study revealed four main findings. First, a three-cluster profile was the best fitting solution for our PD data. These clusters had the following characteristics; Cluster 1 (only vomiting), Cluster 2 (vomiting and laxative use) and Cluster 3 (vomiting, laxative and diuretic use). Secondly, only a few significant differences in the assessed ED, general psychopathology and personality variables were obtained; these were mainly between Cluster 1 and Cluster 3. Overall, Cluster 1 represented a milder version of PD, whereas

**TABLE 2** Clinical comparison between the empirical clusters with the control group

	Means			Pairwise comparisons ( <i>p</i> )			Mean Controls <i>n</i> = 822	Pairwise comparisons ( <i>p</i> )		
	C1 <i>n</i> = 121	C2 <i>n</i> = 55	C3 <i>n</i> = 47	C1 vs C2	C1 vs C3	C2 vs C3		C1 vs Controls	C2 vs Controls	C3 vs Controls
Age of onset (years-old)	18.84	19.58	22.94	.546	.002*	.025*				
Duration (years)	6.89	7.53	6.90	.580	.992	.657				
BMI (current, kg/m <sup>2</sup> )	22.30	22.04	23.26	.681	.140	.107	22.29	.988	.564	.037*
BMI (max., kg/m <sup>2</sup> )	27.66	26.48	28.43	.238	.463	.110	23.60	<.001*	<.001*	<.001
BMI (min., kg/m <sup>2</sup> )	20.04	25.38	19.61	.136	.910	.188	20.04	.999	<.001*	.781
<i>Eating (EDI-2)</i>										
Drive for thinness	14.60	16.25	16.19	.021*	.036*	.942	4.18	<.001*	<.001*	<.001*
Body dissatisfaction	17.37	18.27	18.62	.383	.254	.785	6.44	<.001*	<.001*	<.001*
Interceptive awareness	12.48	12.22	12.91	.776	.653	.534	2.57	<.001*	<.001*	<.001*
Bulimia	5.97	5.65	5.89	.644	.918	.772	1.00	<.001*	<.001*	<.001*
Interpersonal distrust	6.02	6.04	6.87	.975	.209	.288	2.50	<.001*	<.001*	<.001*
Ineffectiveness	11.15	12.20	11.32	.272	.866	.451	2.35	<.001*	<.001*	<.001*
Maturity fears	9.40	9.18	8.13	.795	.147	.296	4.66	<.001*	<.001*	<.001*
Perfectionism	5.69	6.15	7.38	.422	.005*	.077	3.86	<.001*	<.001*	<.001*
Impulse regulation	7.54	8.25	7.53	.395	.995	.482	1.60	<.001*	<.001*	<.001*
Asceticism	7.66	8.27	7.70	.270	.944	.399	2.38	<.001*	<.001*	<.001*
Social insecurity	7.80	8.18	8.36	.576	.435	.828	2.55	<.001*	<.001*	<.001*
Total score	105.4	110.3	110.7	.352	.344	.954	33.7	<.001*	<.001*	<.001*
<i>Psycho. (SCL-90R)</i>										
Somatization	1.91	2.08	2.00	.157	.485	.578	0.68	<.001*	<.001*	<.001*
Obsessive/comp.	1.93	2.04	2.03	.293	.388	.909	0.86	<.001*	<.001*	<.001*
Interpersonal sensitivity	2.07	2.20	2.20	.284	.304	.992	0.78	<.001*	<.001*	<.001*
Depressive	2.29	2.44	2.36	.192	.520	.607	0.79	<.001*	<.001*	<.001*
Anxiety	1.82	1.92	1.87	.398	.683	.735	0.63	<.001*	<.001*	<.001*
Hostility	1.48	1.63	1.39	.272	.484	.133	0.48	<.001*	<.001*	<.001*
Phobic anxiety	1.06	1.23	1.27	.186	.127	.811	0.20	<.001*	<.001*	<.001*
Paranoid	1.58	1.54	1.54	.718	.695	.965	0.66	<.001*	<.001*	<.001*
Psychotic	1.44	1.45	1.42	.942	.882	.851	0.35	<.001*	<.001*	<.001*
GSI score	1.82	1.94	1.90	.222	.474	.703	0.63	<.001*	<.001*	<.001*
PST score	52.15	50.09	53.81	.654	.733	.508	35.89	<.001*	<.001*	<.001*
PSDI score	2.40	2.48	2.51	.281	.160	.738	1.53	<.001*	<.001*	<.001*
<i>Personality (TCI-R)</i>										
Novelty seeking	102.3	101.6	99.5	.749	.232	.439	99.6	.017*	.219	.949
Harm avoidance	118.4	119.6	120.4	.665	.479	.796	100.1	<.001*	<.001*	<.001*
Reward dependence	99.9	101.0	98.1	.633	.432	.285	105.7	<.001*	.007	<.001*
Persistence	109.3	110.4	117.2	.711	.014*	.069	113.1	.012*	.219	.079
Self-directedness	114.2	113.3	115.1	.723	.744	.568	142.9	<.001*	<.001*	<.001*
Cooperativeness	132.5	131.2	134.0	.540	.493	.274	138.1	<.001*	<.001*	.016*
Self-transcendence	66.6	64.6	63.2	.317	.105	.557	63.8	.028*	.659	.749

\*Significant comparison (.05 level).

Cluster 3 was characterised by a more severe presentation of PD. Thirdly, we found distinctiveness for our three clusters from the control group, on the ED and general psychopathology variables, but less so for the personality scales. Fourthly, results showed some correspondence of the three clusters with the DSM-5 (APA, 2013) severity index for purging behaviours for BN. The significance of these findings will be discussed further in the subsequent paragraphs.

#### **4.1 | Cluster analysis of overall PD sample**

Our first findings revealed that distinct subgroups of PD patients emerged using the purging behaviours of vomiting, laxative and diuretic misuse as indicators. To date, no empirically derived PD profile model on a representative distribution of PD patients has been reported in the literature. The best-fitting statistical and clinically meaningful solution revealed a three-cluster profile. Cluster 1 ( $n = 121$ , 54.3%), representing the largest class, was characterised exclusively by vomiting. Conversely, Cluster 2 ( $n = 55$ ; 24.6%) and Cluster 3 ( $n = 47$ , 20.2%) were considerably smaller and presented with multiple purging behaviours. Cluster 2 comprised individuals who vomited and abused laxatives, whereas Cluster 3 entailed all three purging behaviours (vomiting, laxative and diuretic use). In line with our findings, a previous study by Ekeroth et al. (2013), also indicated that 82% of their PD group ( $n = 184$ ), presented with regular vomiting behaviour. In contrast, diuretic and laxative misuse was only observed in 18% and 7% of the PD sample, respectively.

#### **4.2 | Differences across PD clusters and the control sample**

##### **4.2.1 | Differences across PD clusters**

Interestingly, only a few significant differences emerged across the three PD clusters, mainly between Cluster 1 and Cluster 3. Patients in Cluster 1 reported a shorter ED illness duration and lower scores on some of the EDI-2 (drive for thinness and perfectionism) and TCI-R (persistence) subscales than women in Cluster 3. Cluster 1 and Cluster 2 only differed on the EDI-2 drive for thinness variable, with Cluster 2 endorsing a higher drive for thinness than Cluster 1. Differences amongst drive for thinness between the clusters are of interest, given that purging behaviours are currently defined as a means to control weight and shape. Our findings are in line with

other studies (Keel & Striegel-Moore, 2009), which reported that PD patients frequently endorse high levels of drive for thinness, specific dietary rules, and present with an extreme need to control weight and shape. This finding might suggest that future PD research should consider not just weight and shape concerns, but also drive for thinness as a possible motivator for purging behaviours, when defining and characterising PD.

Cluster 3 presented with all three purging methods and had the most considerable mean weekly frequency of overall purging behaviours (mean value of 26.5, compared to 7 and 14.4 for Cluster 1 and 2, respectively). It, therefore, makes sense that Cluster 3 presented with the most severe outcomes in the validation analyses. Previous studies (Edler, Haedt, & Keel, 2007; Keel et al., 2004) have noted differences across single (Cluster 1), versus multiple (Cluster 2 and Cluster 3) purging methods and indicated that the use of various methods of purging was supportive of incremental validity for envisaging ED severity and general psychopathology. Given that Cluster 3 did not just have the highest number of purging methods, but also the highest mean frequency of purging behaviours, it is also possible that purging frequency, rather than the number of purging methods, is a marker of ED severity. Future studies, therefore, would benefit from further clarifying whether the number of purging methods, the frequency of any single purging behaviour, or a combination of both, provide an indication of ED severity in PD patients.

##### **4.2.2 | Differences between PD clusters and the control group (clinical significance)**

Our third main finding was that the three clusters were found to differ significantly from the control group in all eating symptomatology and general psychopathological variables as well as the variable maximum BMI. These findings are in concordance with previous studies (Brown, Haedt-Matt, & Keel, 2011; Fink, Smith, Gordon, Holm-Denoma, & Joiner Jr., 2009; Keel, Holm-Denoma, & Crosby, 2011; Tasca et al., 2012; Wade, 2007), included in the recent meta-analysis by Smith et al. (2017). Our findings corroborate and extend these studies, as we also found higher levels of ED-related and general psychopathology within the three distinct PD clusters when compared to controls. Accordingly, the taxometric studies in the PD literature that have included a control group (Keel et al., 2004; Pinheiro et al., 2008), have also all been able to support a distinction between normality and PD for ED symptomatology by indicating no PD samples in their derived relatively healthy groups.

With regards to maximum BMI, our findings are consistent with prospective longitudinal studies, that have shown that a higher BMI in early adolescence was related to a subsequent BN, BED and PD diagnosis (Allen, Byrne, & Crosby, 2015; Berkowitz et al., 2016; Yilmaz, Gottfredson, Zerwas, Bulik, & Micali, 2019). Conversely, for current BMI, only Cluster 3 presented with a significantly higher BMI than the control group. A higher BMI of PD patients compared to controls and other EDs has also been confirmed in other studies (for a review see Keel, 2019). The higher frequency and more varied methods for purging evident in Cluster 3, may suggest that a higher current BMI is associated with using more extreme weight control methods, which may contribute to a more severe clinical presentation.

Concerning personality, the control group differed statistically from Cluster 1 for all the scales. Still, no differences were found when comparing the control group with Cluster 2 and Cluster 3 for novelty seeking, persistence and self-transcendence. The non-significant findings for Cluster 2 and Cluster 3 for novelty seeking and persistence are surprising, given that Cluster 3 presented with the highest weekly vomiting frequency. This contradicts previous studies (e.g., Brown et al., 2011) that have indicated that higher trait impulsivity is associated with more frequent purging behaviours. However, our results support those of Davis, Smith, and Keel (2020) who found that the PD patients did not score significantly higher on the impulsogenic traits, lack of premeditation and lack of perseverance when compared to controls. Interestingly, PD participants did, however, score substantially higher on negative urgency when compared to controls. Therefore, as the authors conclude, negative urgency may have a particularly important feature of impulsivity for PD symptomatology. In the current study, negative urgency was not assessed. Further studies are therefore needed to replicate our and Davis et al.' (2020) findings. It is also worth noting that our non-significant findings could have resulted from the fact that our control group was significantly younger than the PD group. Research has shown that impulsivity declines with age (Steinberg et al., 2008). Further research would, therefore, benefit from including a control group that is matched in age to the clinical group.

### 4.3 | Correspondence with the DSM-5 severity index for BN

In terms of the correspondence of our three clusters with the DSM-5 severity specifiers, our fourth finding indicated a considerable amount of overlap between the two classification systems; however, the correspondence between the two was imprecise. Specifically, Cluster 1, which based on our

comparison analyses, was deemed the mildest PD form, comprised a total of 23.2% individuals in the severe (8–13 episode) and extreme ( $\geq 14$  episodes) purging categories. Accordingly, for Cluster 3, which was found to be the most severe cluster, 10.6% of the participants were in the moderate (4–7 episode) category. These findings are in concordance with previous studies, that have shown BN severity specifiers not to be associated with more severe ED symptoms and psychopathology across the severity groups (Gianini et al., 2017) or AN (Machado, Grilo, & Crosby, 2017). However, some studies have reported modest trends between the severity groups and severity of the clinical presentation for BN (Grilo et al., 2015; Nakai et al., 2017; Zayas et al., 2018) and AN (Dakanalis, Alix Timko, Colmegna, Riva, & Clerici, 2018; Gianini et al., 2017). Other studies have provided strong concurrent validity for the DSM-5 severity indices concerning ED symptom severity in BED (Dakanalis, Colmegna, Riva, & Clerici, 2017). Given these inconsistent findings, further research investigating the utility of the current DSM-5 BN severity index for PD is required. It would, for instance, be of interest to assess whether the distinct symptom domains obtained from the present analyses, such as drive for thinness, perfectionism, persistence and current BMI, in addition to purging frequency may provide a more accurate marker of severity for PD, rather than purging frequency alone.

### 4.4 | Limitations and strengths

Even though our findings are compelling, the present study is not without limitations. First, our results are based on cross-sectional data collection. Secondly, our data are mainly based on self-reported questionnaires from routine clinical assessments; however, structured clinical interviews and objective measures were also used. Thirdly, our control group was not matched in terms of demographic variables to the PD group, which resulted in the control group being younger than the PD groups. The lack of a paired sampling procedure could have also accounted for other differences obtained between the PD and the control groups (e.g., differences in personality traits). There are two specific reasons why we decided not to match the two groups, which included: (a) to increase the statistical power to identify potential differences between the control group and the three empirical PD clusters and (b) to augment the external validity of the research (i.e., by not matching the samples, our control group was more representative of the original general population of non-ED women). The fourth limitation of the study was that only objective but not subjective binge eating episodes were applied to define our PD group, which was mainly due

to the difficulties in assessing subjective binge eating episodes reliably (Keel, 2007; Keel & Striegel-Moore, 2009). Importance of loss of control during overeating in PD was also not assessed in the current study. Both subjective binge eating episodes and loss of control while overeating, have previously been found to be associated with purging behaviours (Forney, Bodell, Haedt-Matt, & Keel, 2016) and would, therefore, require more detailed attention in further taxometric approaches of PD patients. Fifthly, analyses were restricted to women, raising questions about the generalizability of findings to men with PD. Sixthly, we have no data on diagnostic cross-over in our PD sample. It would be interesting to consider this information in further studies. Finally, even though PD patients also engage in other behaviours to compensate for eating, including excessive exercise and extreme fasting, these behaviours were not included in our PD definition, mainly because there is currently less agreement whether these behaviours should be included in the classification of PD (Pinheiro et al., 2008). Future studies would benefit from providing a more explicit definition regarding these additional compensatory behaviours.

#### 4.5 | Clinical implications

Our findings have shown that PD is a clinically significant disorder for which patients seek treatment. Clinicians are encouraged to provide a careful assessment of specific features of PD patients based on the three PD clusters identified in the current study. At this time, it is not clear what forms of treatment may be most beneficial for PD patients. Our team has initially shown promising results of a cognitive behaviour therapy (CBT) program in reducing purging behaviours and improving ED related symptomatology in a PD sample (Riesco et al., 2018), although with high drop-out rates. Given the few significant differences between the three PD clusters in the current study, it is likely that treatment would benefit all three PD subtypes, however further treatment effectiveness studies, not just using a CBT approach, but also other treatments that are effective in reducing bulimic symptoms, such as interpersonal therapy (Karam, Fitzsimmons-Craft, Tanofsky-Kraff, & Wilfley, 2019; Linardon, Fairburn, Fitzsimmons-Craft, Wilfley, & Brennan, 2017) and dialectical behaviour therapy (Ben-Porath et al., 2020) would need to be assessed in a PD population. Clinicians should try to monitor progress throughout treatment and record those interventions that appear to be useful in changing symptoms with a specific focus on the primary symptoms (e.g., BMI, drive for thinness, perfectionism and persistence) that seem to differentiate across the three PD classes.

## 5 | CONCLUSIONS

Overall, our findings extend the current literature by providing empirical support for our three ED subtypes as clinically significant EDs in terms of ED symptoms and general psychopathology, but further research needs to be undertaken to see whether this distinction also applies to personality. The lack of congruence between the three derived symptom clusters and DSM-5 severity criteria suggest future research is required to clarify further the relationships between symptom severity and dimensional differences in PD. Also, we must continue to examine symptom severity as it pertains to prognostic outcomes for PD. The possibility remains that the frequency of purging behaviours is not the defining feature of prognosis or recovery from PD, and as such defining severity by this metric is not informative. Further research is therefore required which utilises taxometric approaches on PD illness course, outcome, or treatment response to better characterise this disorder. Further, our understanding of the defining features of PD is impaired given the gaps in the literature about the: (a) the minimum frequency of purging behaviours to consider them clinical significant; (b) the difference between single versus multiple purging methods; (c) the importance of objective versus subjective binge eating that precedes PD and (d) the nature of body image problems that might best characterise PD patients. There should be flexibility, but still consistency in the way PD is being defined as our understanding of this condition improves. Without such knowledge, it is premature to include PD in DSM-6. Presently, the mostly like course is to continue including PD in DSM with an explicit mention that it is a provisional diagnosis in need of further study.

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