

# Use of Latent Profile Analysis to Identify Eating Disorder Phenotypes in an Adult Australian Twin Cohort

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**Context:** The relationships among the different eating disorders that exist in the community are poorly understood, especially for residual disorders in which bingeing or purging occurs in the absence of other behaviors.

**Objective:** To examine a community sample for the number of mutually exclusive weight and eating profiles.

**Design:** Data regarding lifetime eating disorder symptoms and weight range were submitted to a latent profile analysis. Profiles were compared regarding personality, current eating and weight, retrospectively reported life events, and lifetime depressive psychopathology.

**Setting:** Longitudinal study among female twins from the Australian Twin Registry in whom eating was assessed by a telephone interview.

**Participants:** A community sample of 1002 twins (individuals) who had participated in earlier waves of data collection.

**Main Outcome Measures:** Number and clinical character of latent profiles.

**Results:** The best fit was a 5-profile solution with women who were (1) of normal weight with few lifetime eating disorders (4.3%), (2) overweight (10.6% had a lifetime eating disorder), (3) underweight and generally had no eating disorders except for 5.3% who had restricting anorexia nervosa, (4) of low to normal weight (89.0% had a lifetime eating disorder), and (5) obese (37.0% had a lifetime eating disorder). Each profile contained more than 1 type of lifetime eating disorder except for the third profile. Women in the first and third profiles had the best functioning, with women in the fourth and fifth profiles having similarly poorer functioning. The women in the fourth group had a symptom profile distinctive from the other 4 groups in terms of severity; they were also more likely to have had lifetime major depression and suicidality.

**Conclusion:** Lifetime weight ranges and the severity of eating disorder symptoms affected clustering more than the type of eating disorder symptom.

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**O**UR UNDERSTANDING OF the diagnostic classification of eating disorders wields enormous influence over the direction of research and clinical practice in this field, affecting the development of etiologic models of eating disorders, the form of treatments developed for specific disorders, and the availability of these treatments.<sup>1,2</sup> However, the relationship among the different eating disorders is poorly understood, especially with respect to the DSM-IV diagnosis of “eating disorder not otherwise specified” (EDNOS), which represents the most common diagnosis made in outpatient settings but the one most ignored by researchers because of its status as a *residual diagnosis*,<sup>2</sup> defined as a disorder of clinical severity in which the diagnostic criteria of bulimia nervosa (BN) or anorexia nervosa (AN) are not met.

Hence, empirical research that can clarify the differences among categories of eating disorders (including residual diagnoses) becomes an important priority. Latent class analysis (LCA)<sup>3</sup> is an empirical tool used previously to investigate the question of whether heterogeneous eating disorder symptoms coaggregate at above-chance levels to form homogeneous eating disorder categories. Three such studies<sup>4-6</sup> have limited the investigation to bulimic symptoms. Results from 1 study<sup>4</sup> suggest the existence of 2 classes characterized not so much by eating disorder symptoms but by degree of comorbidity. The other 2 studies describe 4 classes in which grouping occurred according to the frequency of binge eating and self-induced vomiting<sup>5</sup> and 3 classes in which a BN subtype was identified along with a bingeing-only and a purging-only disorder.<sup>6</sup>

Two other LCA studies investigated anorexia and bulimic symptoms. A recent study<sup>7</sup> examined a large cohort (N=1179) of affected relative pairs that consisted of an eating disorder proband (having AN or BN) and an affected biological relative. This study distinguished 4 classes, where 2 classes resembled restricting AN (1 accompanied by high levels of compulsions), an AN and BN class typified by multiple methods of purging, and a BN class. The second study<sup>8</sup> examined a community twin population delineating a 6-class solution among the 1071 women who had responded positively to at least 1 of the eating disorder screening questions. Three of the classes broadly resembled the *DSM-IV* classifications of AN, BN, and binge eating disorder (BED). A shape- and weight-preoccupied class, a class with low weight with binge eating, and a class with low weight without binge eating were further delineated. This study has been criticized on the grounds of using an interview with “skip” rules based on *DSM-IV* definitions to reduce the overall length of the interview.<sup>7</sup> Therefore, the potential utility of symptom clusters not used in *DSM-IV* was not investigated.

The present study seeks to extend the small body of literature in which LCA approaches have been used by expanding the capability for identification and inclusion of residual eating disorders. This is achieved in several ways. First, we investigated a large community twin population in which some women experienced disordered eating and others did not. In this way, we can view the eating disorder categories in the context of the full range of eating and weight found in the community and can classify all individuals (regardless of the presence of lifetime eating behavior). Second, we used the Eating Disorder Examination (EDE),<sup>9</sup> adapted to delineate lifetime eating disorder behaviors, in which all behaviors were assessed (ie, no skip rules were used). Third, to our knowledge, this is the first study in the area of eating disorders to use latent profile analysis (LPA), which can incorporate continuous, ordinal, and categorical indicators, in contrast to LCA, which can only accommodate categorical indicators.

## METHODS

### PARTICIPANTS

The sample of twins approached to participate in this study was originally derived from a cohort of 8536 twins (4268 pairs) born from 1964 to 1971, who were registered as children with the Australian Twin Registry from 1980 to 1982, in response to media appeals and systematic appeals through schools. Female-female twins who had participated in at least 1 of 2 waves of data collection<sup>10</sup> (one from 1989 to 1992, when the twins were aged 18 to 25 years, and the other from 1996 to 2000) were approached to participate in the present study. In the third wave of data collection, 2320 twins (1140 complete pairs) were approached by the Australian Twin Registry from 2001 to 2003, of whom 1083 individual twins (46.7%) consented to participate, 568 (24.5%) did not agree to participate, and 669 (28.8%) did not respond. At least 1 further telephone call or letter was used to contact the nonresponders. The mean±SD age of the women at the time of the data collection was 35±2.11 years (age range, 28-40 years). The protocol consisted of 2 parts, a telephone interview and a self-report questionnaire. In all, 1002

women completed the interview. Demographic variables predicting participation have been previously outlined,<sup>10</sup> but participation at wave 3 was not predicted by a wave 2 diagnosis of major depression (odds ratio, 0.91; 95% confidence interval, 0.71-1.18; *P*=.48) or by the number of eating problems at wave 1 (*t*<sub>960</sub>=1.00, *P*=.32), using questions that have been published previously<sup>11</sup> or by any of the 16 individual eating problems making up this total (including AN, BN, weight loss, obesity, binge eating, low body weight, and having ever suffered from or been treated for an eating disorder). The Flinders University Clinical Research Ethics Committee approved the data collection process, and written informed consent was obtained after the procedures had been fully explained.

Lifetime eating disorder diagnoses were ascertained using the EDE.<sup>9</sup> Nineteen women (1.9%) met full *DSM-IV* criteria for lifetime AN, and 16 (1.6%) further met the criteria for AN except for amenorrhea (“partial AN”). A further 8 women (0.8%) also met AN criteria, but their amenorrhea status was less clear (eg, some were taking the oral contraceptive pill at the time of low weight). Of 43 women meeting the criteria for lifetime AN (full or partial), 18 had restricting type. Thirty-five women met full *DSM-IV* criteria for BN, among whom 6 had also had AN, leaving 29 women (2.9% of the total sample), with 7 of these having nonpurging BN. Two EDNOS categories were also identified. First, a provisional diagnosis of BED was given to 29 of the women who reported experiencing objective binge episodes at least twice a week for a 3-month period without a break of more than 2 weeks that was not concurrent with any threshold (ie, at least twice a week during a 3-month period) compensatory behaviors. Although this does not meet the full *DSM-IV* criteria, it provides an indicator of likely lifetime occurrence. Second, *EDNOS-p* was defined as the presence of threshold purging (ie, vomiting and the use of diuretics or laxatives) in the complete absence of lifetime objective binge episodes. This disorder has received recent research attention.<sup>12-14</sup> There were 53 women (5.3%) in this category who did not meet lifetime criteria for any other eating disorder. The prevalence of eating disorders among this group has been reported more fully elsewhere.<sup>15</sup>

### WAVE 3

The telephone interview used the 14th edition of the EDE,<sup>9</sup> which included questions relating to dietary restraint, behavioral features of eating disorders, and concerns about eating, shape, and weight during the last 28 days. All diagnostic questions addressed a 3-month time frame. To allow for the assessment of lifetime disorders using *DSM-IV* diagnostic criteria, the EDE was revised in 7 ways with insertion of lifetime questions, including the age range during which the behavior occurred to assess the co-occurrence of features. First, because the EDE does not assess fasting (except for subjects who have experienced concurrent binge episodes), a 3-month and lifetime version of the “avoidance of eating” question was included. The criterion was met if the person had gone for 8 waking hours or more without eating anything to affect their shape or weight on more than half of the days each week for a 3-month period. Second, lifetime occurrence of objective binge eating was assessed with an additional question about whether the behavior met threshold criteria (at least twice a week for a 3-month period with breaks of ≤2 weeks). Third, lifetime questions assessing the use of laxatives, diuretics, self-induced vomiting, and excessive exercise were included, along with questions about threshold frequency. *Excessive exercise* was defined as driven or compulsive exercise that had occurred for at least 1 hour 5 days a week for a 3-month period with no breaks of more than 2 weeks. Abstinence from these weight control behaviors

for 2 weeks or more was assessed by a follow-up question, as was co-occurrence with any binge eating behavior. Fourth, the level of shape and weight concern during any lifetime objective binge eating behavior was assessed. Fifth, we assessed desired weight, current weight and height, and highest (excluding pregnancy) and lowest (excluding physical illness) weight since 15 years of age. Sixth, if the person met AN weight criteria for at least 3 months, then the fear of weight gain and the notion of fatness during this time were also assessed: the diagnostic threshold for both was occurrence for more than half of the days during the period. Seventh, also assessed during this time was amenorrhea, the level of concern about shape and weight, and the maintenance of low weight (or trying to lose weight). Subthreshold behavior was occurrence less than the required weekly frequency during a 3-month period or occurring at the required weekly frequency for less than a 3-month period.

All interviewers were postgraduate clinical psychology trainees (n=10) who had been trained in the use of the EDE. Each of the interviews was taped, and corrective feedback was provided until the interviewer had acquired the skills needed to complete the interview independently. Monthly group meetings were conducted to discuss the interview process, which ensured interview fidelity. Blind independent ratings of the presence of lifetime objective binge episodes, using a random selection of 22 taped interviews (5 featuring BED, 9 with lifetime BN, and 8 in whom purging had occurred in the absence of objective binge episodes), showed agreement about the absence or presence of objective binge episodes on all occasions except 1 (a woman with BN, because of ambiguity about the amount of food consumed when her eating was out of control).

Measures relating to temperament and to early life experiences (in the first 16 years of life) were completed by the twins. These are summarized in **Table 1**.

## WAVE 2

The semi-structured assessment for the genetics of alcohol (SSAGA)<sup>21</sup> was used to assess the lifetime presence of DSM-IV criteria for major depression. In addition, a 4-point scale of lifetime suicidality was derived, in which 0 indicates no suicidal ideation; 1, any suicidal thoughts; 2, persistent thoughts; and 3, suicide attempt.

## STATISTICAL ANALYSIS

### Latent Profile Analysis

Like LCA, LPA is based on the assumption that frequencies with which different item endorsement profiles occur can be explained by the existence of a few mutually exclusive respondent classes. Although LCA is restricted to dichotomous indicator variables (eg, the presence or absence of different symptoms), LPA is an extension of LCA that can accommodate continuous, ordinal, and categorical indicators. Latent profile analysis is based on the principle of *conditional independence*,<sup>22</sup> which dictates that classes be created such that (within each class) indicator variables are statistically independent (ie, uncorrelated). For example, a latent class may be created that is characterized by high levels of bingeing and purging. For individuals within that class, the variation of bingeing and purging is restricted. Consequently, the covariation (ie, correlation) between bingeing and purging within that class (but not across classes) is limited. With respect to indicator variables, we included 6 behavioral DSM-IV diagnostic criteria as indicators (**Table 2**), in addition to the highest and lowest body mass index (BMI) (calculated as weight in kilograms divided by height in meters squared) during the lifetime. Amenorrhea

**Table 1. Summary and Description of the Wave 3 Measures Used in the Validation Analysis**

Variable	Description and Cronbach $\alpha$
Self-esteem	Rosenberg Self-esteem Scale <sup>16</sup> : 10 items, $\alpha = .87$
Impulsivity	Barratt Impulsiveness Scale <sup>17</sup> : 30 items, $\alpha = .81$
Perfectionism: concern about mistakes, personal standards, doubts about actions, and parental expectations and parental criticism*	Frost et al Multidimensional Perfectionism Scale <sup>18</sup> : 9 items, $\alpha = .90$ ; 7 items, $\alpha = .85$ ; 4 items, $\alpha = .82$ ; 5 items, $\alpha = .86$ ; and 4 items, $\alpha = .89$
Parental conflict*	Revised Moos Family Environment Scale, conflict subscale <sup>19</sup> : 9 items, $\alpha = .73$
Comments about weight from family, other adults, and peers*	Risk Factor Interview <sup>20</sup> : 5 items, $\alpha = .88$
Body mass index by self-report	Calculated as weight in kilograms divided by height in meters squared
Eating Disorder Examination, <sup>9</sup> last 30 days	Weight concern: 5 items, $\alpha = .74$ ; shape concern, 7 items, $\alpha = .86$ ; eating concern, 5 items, $\alpha = .72$ ; and dietary restraint, 5 items, $\alpha = .60$

\*Assessed during the first 16 years of life.

was not included because its inclusion prevented the LPA's converging to a solution, probably because of its comparatively low endorsement rate. Attitudinal components of the diagnostic criteria (eg, weight and shape concern) were not included because of the difficulties of assessing this meaningfully during the lifetime. Latent profile analysis was conducted based on a generalized linear model with multinomial distribution. Standard errors for parameter estimates were adjusted using a sandwich estimator<sup>23</sup> to consider the nonindependence of observations between twin pairs. The number of clusters was determined jointly on the minimization of the Bayesian information criteria parsimony index<sup>24</sup> and the minimization of cross-classification probabilities. Assignment of cluster membership was based on Bayesian probabilities. Analysis was performed using Mplus version 3.12 (Muthén & Muthén, Los Angeles, Calif).<sup>23</sup>

### Validation Analysis

Validation analyses permitted examination of the descriptors of the latent classes. Measures were selected on the basis of prior empirical associations for their associations with eating disorders.<sup>20,25</sup> Analyses with continuous variables were conducted using linear mixed-effects modeling in SPSS version 12.0.2 for Windows (SPSS Inc, Chicago, Ill), with fixed-effects models with nonresidual errors because our data set contains correlated observations (twin pairs), which violated the assumption of independent sampling. This procedure specifies a more general covariance structure for the residual errors, adjusting the standard errors for nonindependent observations. A Bonferroni-corrected  $\alpha$  level of .003 was used to evaluate associations between latent class and validation variables (representing 16 independent analyses), and Bonferroni corrected adjustment was also used to evaluate all post hoc analyses. With respect to our dichotomous variable (major depression), given that SPSS has no way of dealing with such variables that are correlated observations, we used the conservative adjustment procedure outlined previously by Kendler and Gardner.<sup>26</sup>

**Table 2. Body Mass Index (BMI) Variables and Endorsement of Lifetime Eating Disorder Behaviors Entered Into the Latent Profile (LP) Analysis\***

Variable	LP1 (n = 400)	LP2 (n = 285)	LP3 (n = 171)	LP4 (n = 87)	LP5 (n = 54)
<b>BMI†</b>					
Lowest					
Mean ± SD	19.41 ± 1.26	22.09 ± 1.98	17.27 ± 1.10	17.53 ± 2.45	27.26 ± 3.91
Range	15.94-20.45	14.69-28.23	13.06-19.27	10.01-22.38	10.01-22.38
Highest					
Mean ± SD	24.12 ± 1.53	30.00 ± 2.82	20.58 ± 1.25	23.55 ± 2.50	41.29 ± 6.87
Range	20.45-27.92	23.92-39.06	17.36-23.38	17.90-29.67	32.05-63.98
<b>Behavioral DSM-IV Diagnostic Criteria‡</b>					
Objective binge episodes					
0	385 (96.7)	251 (89.0)	170 (99.4)	55 (63.2)	38 (70.4)
1	11 (2.8)	10 (3.5)	1 (0.6)	3 (3.4)	3 (5.6)
2	2 (0.5)	21 (7.4)	0	29 (33.3)	13 (24.1)
Self-induced vomiting					
0	378 (99.7)	265 (99.6)	168 (100.0)	25 (32.9)	44 (84.6)
1	0	0	0	0	0
2	1 (0.3)	1 (0.4)	0	51 (67.1)	8 (15.4)
Laxative abuse					
0	374 (93.5)	263 (92.3)	171 (100.0)	40 (46.0)	43 (79.6)
1	18 (4.5)	14 (4.9)	0	20 (23.0)	4 (7.4)
2	8 (2.0)	8 (2.8)	0	27 (31.0)	7 (13.0)
Diuretic abuse					
0	389 (97.3)	270 (95.1)	169 (98.8)	76 (87.4)	46 (85.2)
1	7 (1.8)	9 (3.2)	2 (1.2)	5 (5.7)	5 (9.3)
2	4 (1.0)	5 (1.8)	0	6 (6.9)	3 (5.6)
Fasting					
0	355 (89.4)	251 (88.1)	163 (95.3)	23 (26.4)	40 (74.1)
1	33 (8.3)	21 (7.4)	6 (3.5)	22 (25.3)	8 (14.8)
2	9 (2.3)	13 (4.6)	2 (1.2)	42 (48.3)	6 (11.1)
Driven excessive exercise					
0	394 (98.5)	269 (94.4)	165 (96.5)	57 (65.5)	54 (100.0)
1	6 (1.5)	16 (5.6)	5 (2.9)	25 (28.7)	0
2	0	0	1 (0.6)	5 (5.7)	0
Total No. with subthreshold or threshold behaviors	81 (20.3)	76 (26.7)	16 (9.4)	75 (86.2)	23 (42.6)

\*Data are given as number (percentage) unless otherwise indicated.

†Calculated as weight in kilograms divided by height in meters squared.

‡0 indicates not present; 1, present at subthreshold levels; and 2, present at threshold levels. Some variables do not sum to the LP totals because of missing data.

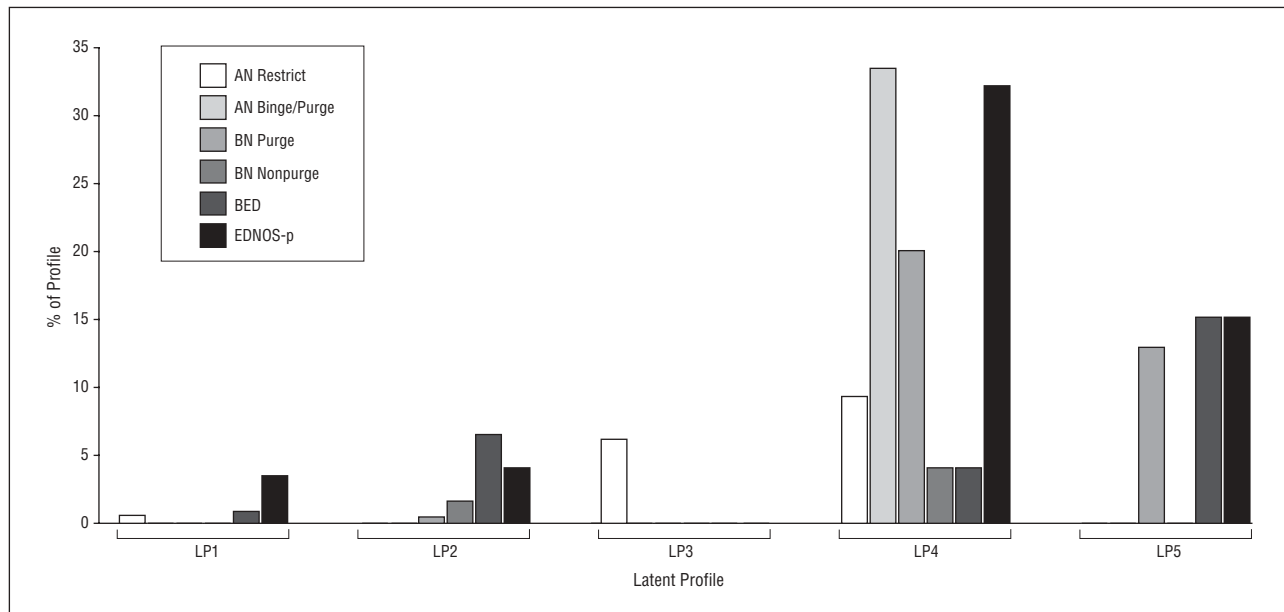
## RESULTS

### LATENT PROFILE ANALYSIS

The LPA analysis revealed a clear and unambiguous 5-class solution. Of the 997 women included in the analysis (among whom complete data on all indicators were present), 400 (40.1%) were members of latent profile (LP) 1, 285 (28.6%) were members of LP2, 171 (17.2%) were members of LP3, 87 (8.7%) were members of LP4, and 54 (5.4%) were members of LP5. The distribution of eating disorder symptoms and BMI variables across the latent classes are given in Table 2, along with the number of women in each group who reported at least 1 lifetime subthreshold or threshold eating disorder behavior. The LP1 class consisted of women who had generally remained in the healthy weight range during their adult life. This group had experienced low levels of lifetime eating disorder behaviors, with most women with such behaviors experiencing them at subthreshold levels. Collapsing the subthreshold and threshold categories of

lifetime eating disorder behavior, 13 (3.3%) had experienced objective binge episodes, 1 (0.3%) had used self-induced vomiting, 26 (6.5%) had used laxatives, 11 (2.8%) had used diuretics, 42 (10.5%) had used fasting, and 6 (1.5%) had used driven exercising. There were few lifetime eating disorder diagnoses represented in this group (**Figure 1**), with only 17 (4.3%) having an eating disorder (12 women having EDNOS-p, 3 having lifetime BED, and 2 having lifetime AN [both restricting]).

The LP2 class consisted of women who tended to be in the healthy to overweight weight range during their lifetime. These women had significantly higher lowest BMI ( $t_{443.61} = -20.01, P < .001$ ) and highest BMI ( $t_{399.96} = -31.85, P < .001$ ) than the women in LP1. They also reported significantly higher levels of objective binge episodes ( $\chi^2_2 = 24.91, P < .001$ ) and driven exercising ( $\chi^2_1 = 9.06, P = .003$ ) than the women in LP1. About twice as many women in this group had a lifetime eating disorder compared with those in LP1, affecting 31 women (10.9%) (16 women having BED, 10 having EDNOS-p, and 5 having BN [only 1 of whom had purging subtype]).



**Figure 1.** Distribution of *DSM-IV* diagnostic categories across the latent profiles. AN indicates anorexia nervosa; BED, binge eating disorder; BN, bulimia nervosa; EDNOS-p, eating disorder not otherwise specified–purging; and LP, latent profile.

In contrast, the women in LP3 remained in the underweight range during their adult lives, and this low weight was maintained by most without reliance on weight loss behaviors, although some had used fasting or driven exercise. In this group, there were only 9 women (5.3%) with a lifetime eating disorder, all having restricting type AN.

The LP4 class contained the most women with eating disorders, with 3 women having BED, 24 having EDNOS-p, 18 having BN (15 with purging subtype), and 32 having AN (7 with restricting subtype). In total, 88.5% of this group had a lifetime eating disorder. A large proportion of women with eating disorders were in LP4 (eg, 10.3% of the women with BED, 45.3% of the women with EDNOS-p, 74.4% of the women with lifetime AN, 68.2% of the women with lifetime BN [purging type], and 42.9% of the women with lifetime BN [nonpurging type]). Also in LP4 were 84.2% of the women who met strict criteria for AN (presence of amenorrhea), with the 3 remaining women in LP3. Collapsing the subthreshold and threshold eating disorder behaviors, it can be seen that fasting (73.6%), self-induced vomiting (67.1%), and laxative use (54.0%) were the most widely used forms of weight control behavior. Only about one third of the group reported objective binge episodes. The lifetime BMI ranged between underweight and healthy.

The final group, LP5, had an adult weight ranging from overweight to morbidly obese. Compared with the other groups, they reported the second highest prevalence of lifetime eating disorder behaviors except for driven exercise. Correspondingly, this group contained the second highest proportion of women with lifetime eating disorders (37.0%), 7 with BED, 7 with EDNOS-p, and 6 with BN (all purging subtype).

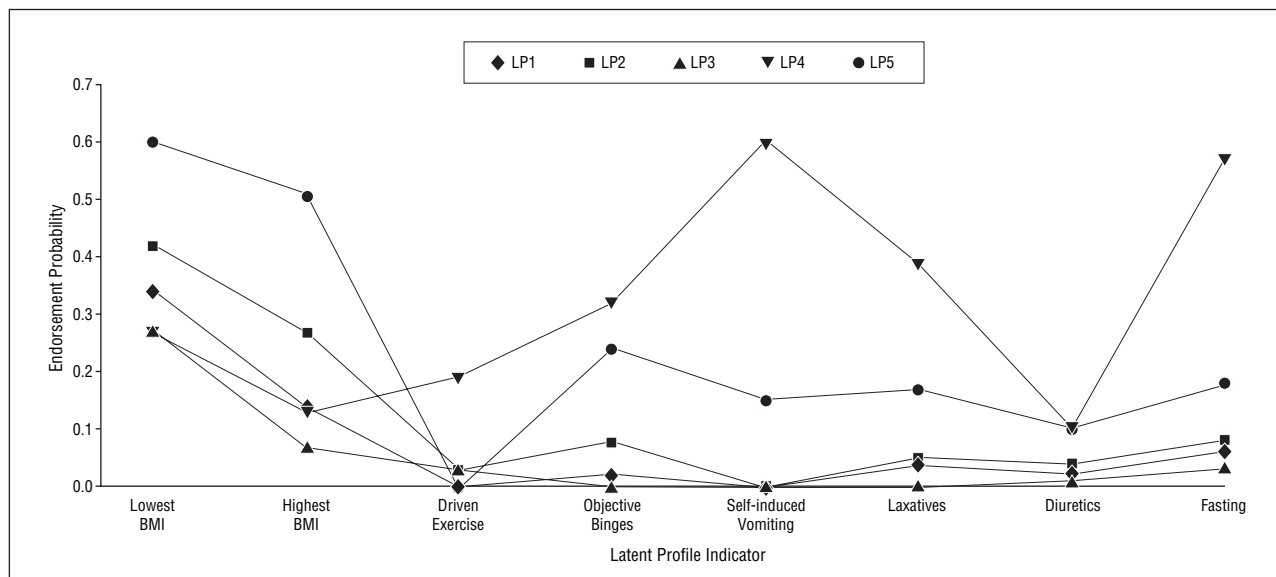
The symptom endorsement probability, shown in **Figure 2**, suggests that at least 3 of the profiles (LP1 through LP3) represented a severity continuum of eating disorder symptoms, as indicated by the monotonic increase in the endorsement probability. In contrast, the

fourth profile (LP4) may show evidence of discontinuity, suggestive of a separate condition, given that self-induced vomiting, laxative use, and fasting show at least a 50% increase in endorsement from the next closest profile (ie, LP5), considered to represent the criterion for discontinuity.<sup>27</sup> Furthermore, LP5 shows some tendency toward discontinuity, especially with respect to binge eating.

#### VALIDATION ANALYSIS

**Table 3** gives the validation analyses of the LPs. Current BMI was significantly different among the groups, with women in LP3 having the lowest BMI. Women in LP1 and LP4 did not differ from each other with respect to BMI, and both groups had a significantly lower BMI than women in LP2, who had a significantly lower BMI than women in LP5. The groups showed significant differences on all the EDE measures of current behavior and attitudes related to eating. Examination of weight and shape concern showed women in LP3 to have the lowest levels, followed by women in LP1, then women in LP2 and LP4, with women in LP5 having the highest levels of these concerns. Eating concern was equivalent across LP1 and LP3, with women in LP2 and LP4 having higher eating concern, and women in LP5 having the highest level of eating concern. Women in LP3 reported the least dietary restraint, followed by women in LP1, then women in LP2 and LP4, with women in LP5 reporting the highest levels.

For early life events, the groups differed only with respect to parental criticism and comments about weight or eating. The women in LP1 and LP3 tended to report most favorably with respect to these early life events, and women in LP4 and LP5 had significantly higher levels of parental criticism and comments about weight. Women in LP5 reported higher levels of comments about weight than women in LP4.



**Figure 2.** Profile plot for the 5-profile model. Endorsement probabilities indicate proportion of individuals in each profile with each indicator. BMI indicates body mass index; LP, latent profile.

**Table 3. Current Eating and Weight, Life Events, Psychopathology, and Personality Across the Latent Profiles (LP)\***

Variable	LP1	LP2	LP3	LP4	LP5	t Statistic (df)	P Value
<b>Current Eating and Weight</b>							
Body mass index	22.49 ± 1.82 <sup>a</sup>	27.43 ± 3.07 <sup>b</sup>	19.60 ± 1.27 <sup>c</sup>	21.82 ± 2.23 <sup>a</sup>	36.54 ± 7.31 <sup>d</sup>	8.23 (809.48)	<.001
Weight concern	0.90 ± 0.84 <sup>a</sup>	1.58 ± 1.23 <sup>b</sup>	0.58 ± 0.70 <sup>c</sup>	1.57 ± 1.26 <sup>b</sup>	2.32 ± 1.52 <sup>d</sup>	6.10 (941.12)	<.001
Shape concern	1.11 ± 1.03 <sup>a</sup>	1.71 ± 1.33 <sup>b</sup>	0.73 ± 0.83 <sup>c</sup>	1.85 ± 1.38 <sup>b</sup>	2.48 ± 1.70 <sup>d</sup>	5.65 (978.12)	<.001
Eating concern	0.10 ± 0.26 <sup>a</sup>	0.25 ± 0.53 <sup>b</sup>	0.07 ± 0.17 <sup>a</sup>	0.27 ± 0.72 <sup>b</sup>	0.72 ± 1.13 <sup>c</sup>	6.35 (991.49)	<.001
Dietary restraint	0.58 ± 0.88 <sup>a</sup>	0.99 ± 1.03 <sup>b</sup>	0.26 ± 0.55 <sup>c</sup>	0.95 ± 1.33 <sup>b</sup>	1.43 ± 1.38 <sup>d</sup>	3.50 (993.12)	<.001
<b>Life Events During the First 16 y of Life</b>							
Parental expectations	2.03 ± 0.56	2.09 ± 0.54	1.98 ± 0.50	2.28 ± 0.67	2.19 ± 0.52	2.61 (878.66)	.009
Parental criticism	1.78 ± 0.59 <sup>a</sup>	1.87 ± 0.57	1.67 ± 0.52 <sup>a</sup>	2.07 ± 0.74 <sup>b</sup>	2.09 ± 0.76 <sup>b</sup>	3.36 (896.63)	.009
Parental conflict	2.10 ± 0.45	2.07 ± 0.43	2.04 ± 0.47	2.22 ± 0.53	2.11 ± 0.50	0.77 (770.89)	.44
Comments about weight	1.93 ± 0.65 <sup>a</sup>	2.22 ± 0.64 <sup>b</sup>	1.97 ± 0.67 <sup>a</sup>	2.41 ± 0.68 <sup>b</sup>	2.77 ± 0.72 <sup>c</sup>	7.74 (926.93)	<.001
<b>Psychopathology at Wave 2</b>							
Depression, No. (% age)	125.0 (31.3)	97.0 (34.0)	38.0 (22.1)	54.0 (61.4)	19.0 (35.2)	4.65†	.03
Suicidality	0.38 ± 0.77 <sup>a</sup>	0.48 ± 0.85 <sup>a</sup>	0.26 ± 0.64 <sup>a</sup>	0.98 ± 1.12 <sup>b</sup>	0.67 ± 1.04	3.73 (989.41)	<.001
<b>Personality</b>							
Self-esteem	3.23 ± 0.41 <sup>a</sup>	3.06 ± 0.43 <sup>b</sup>	3.28 ± 0.37 <sup>a</sup>	2.92 ± 0.56 <sup>b</sup>	2.87 ± 0.55 <sup>b</sup>	5.55 (928.42)	<.001
Concern about mistakes	1.81 ± 0.45 <sup>a</sup>	1.93 ± 0.46 <sup>b</sup>	1.82 ± 0.49 <sup>ab</sup>	2.18 ± 0.54 <sup>c</sup>	2.13 ± 0.59 <sup>c</sup>	5.80 (942.60)	<.001
Personal standards	2.43 ± 0.47	2.45 ± 0.49	2.43 ± 0.53	2.71 ± 0.56	2.50 ± 0.51	2.75 (912.45)	.006
Doubt about actions	1.96 ± 0.49 <sup>a</sup>	2.04 ± 0.58	1.89 ± 0.48 <sup>a</sup>	2.19 ± 0.62 <sup>b</sup>	2.23 ± 0.57 <sup>b</sup>	3.09 (917.50)	.002
Impulsivity	2.03 ± 0.28	2.04 ± 0.28	1.98 ± 0.29	2.08 ± 0.34	2.13 ± 0.33	1.44 (929.98)	.15

\*Data are given as mean ± SD unless otherwise indicated. Variables are measured at wave 3 unless otherwise indicated. Superscripts that differ represent significant differences (Bonferroni adjusted) among LPs on that variable.

†Wald t<sub>1</sub> statistic.

With respect to psychopathology, the differences for lifetime depression did not reach significance according to our adjusted significance level. However, a comparison of percentages shows women in LP3 to have the lowest levels of lifetime depression, whereas women in LP1, LP2, and LP5 had higher but equivalent levels. In contrast, women in LP4 had 2 to 3 times higher levels of lifetime depression than the other 4 groups. The level of lifetime suicidality was significantly different among the groups, with LP1, LP2, and LP3 having equivalent rates, all significantly less than the women in LP4. The women in LP5 were somewhere be-

tween these 2 levels of suicidality. Similar patterns were obtained with respect to personality. Self-esteem, concern regarding mistakes, and doubt about actions (which can be taken to indicate some degree of obsessionality given that 3 of 4 items are adapted from the Maudsley Obsessional Compulsive Inventory<sup>18</sup>) were significantly different among the groups. Women in LP1 and LP3 were equivalent with respect to these measures, followed by women in LP2, with women in LP4 and LP5 reporting the lowest levels of self-esteem and the highest levels of concern regarding mistakes and doubt about actions.

Five LPs were identified in this community group of women, a sample including women who may or may not have experienced eating disorder behavior in their lifetime. Within the context of the full range of eating to be found in the community, there was not strong support for the current distinctions among different diagnoses, with clustering more affected by lifetime weight ranges and the severity of the eating disorder symptoms rather than the type of eating disorder behavior. In terms of a severity continuum, LP3, LP1, LP2, and LP5 represented an ascending severity of eating disorder symptoms along with associated psychopathology. In contrast, LP4 showed possible evidence of discontinuity and was almost completely composed of women with lifetime eating disorders (including EDNOS), who displayed the most severe level of eating disorder behaviors and the highest levels of lifetime depressive symptoms. This latter finding was consistent with previous findings with respect to BN and restricting AN,<sup>4,7</sup> in which these eating disorders tend to cluster according to comorbidity rather than according to differences in diagnostic criteria.

Three identified profiles, representing most of the sample (85.9%), can be said to represent normative groups. The women in LP1 showed good adjustment, healthy weight, and low levels of disordered eating. The women in LP3 also demonstrated good adjustment (in some cases better than the women in LP1), with an absence of any eating disorders (except for 9 women who had restricting AN), among whom there was chronically and naturally occurring (achieved without dietary restriction and not evidenced by shape or weight concern) low weight. This group resembled the women in the low weight class previously identified by Bulik and colleagues.<sup>8</sup> The women in LP2 showed good adjustment but had significantly lower self-esteem than the women in LP1 and LP3. Associated with this overweight status were a higher level of eating disorders and a slightly greater use of eating disorder behaviors than the women in LP1, albeit typically at subthreshold levels (ie, only 37.8% of the reported purging type behaviors [vomiting and laxative or diuretic use] met threshold levels).

The LP5 class included women who were obese, had the poorest adjustment with respect to current behaviors and attitudes related to eating, and were equivalent to the eating disorder group with respect to self-esteem, concern about mistakes, and obsessionality. Three eating disorders were represented in this profile (BN, BED, and EDNOS-p), and these women exhibited a high level of eating disorder symptoms, with 66.7% of the reported purging type behaviors meeting threshold levels. Obesity was associated with poor adjustment with respect to many of the variables that we measured (except for suicidality and depression) and was associated with an increased risk for an eating disorder, with almost 4 times the prevalence of the overweight group in the LP2 class.

The remaining profile, LP4, can be seen to be an eating disorder group, among whom all of the 6 types of eating disorders shown in Figure 1 were represented. These women demonstrated poor levels of adjustment and had normal

weight, among whom 77.1% of the reported purging-type behaviors met threshold levels. This profile is consistent with a transdiagnostic approach,<sup>2</sup> which highlights the features shared across different eating disorders, including EDNOS. This position asserts that cross-diagnostic similarities (eg, binge eating, extreme dietary restraint, self-induced vomiting, and overevaluation of control of eating, weight, and shape) become more marked during a lifetime perspective, as patients move between *DSM-IV* diagnoses over time.<sup>28</sup> This group was differentiated from the other groups by an association with a high level of depression and suicidality and may represent the “clinical eating disorders” (ie, those more likely to seek treatment) given that severity of eating disorder symptoms has been found to differentiate between clinic and community BN cases.<sup>29</sup> This supports consideration of EDNOS as being clinically equal in importance to AN or BN.

This study represents a unique investigation of a community sample with respect to the identification of latent groupings. The results should be interpreted in the context of 5 major limitations. First, although we have a large sample that is comparable to other LCA sample sizes,<sup>5,7</sup> we had a moderate response rate (46.7%). This rate is commensurate with a large population study<sup>30</sup> in Australia but lower than another study.<sup>31</sup> There was no indication that a history of disordered eating influenced response, nor did a previous study<sup>32</sup> of twins using interviews focused only on eating indicate that response was biased by previous eating problems. However, women with poor outcome with respect to their eating disorder may have been underrepresented in the present study. In addition, women with more severe symptoms may have recalled more symptoms, thus affecting clustering. Second, although we used a reliable and valid eating disorder interview, the accuracy of the EDE for reporting retrospective eating disorder symptoms is unknown. Evidence suggests that interview-based assessments result in BN being as reliably reported as major depression,<sup>33</sup> with major depression having a  $\kappa$  statistic of 0.61 during a 6-year period using a structured psychiatric assessment.<sup>34</sup> Previous research has also shown that reliability of lifetime reporting is increased with the severity of the eating symptoms.<sup>33,35</sup> Third, we included only eating behaviors in our LPA to increase the reliability of retrospective recall, but in doing so, we did not include the cognitive diagnostic criteria of eating disorders. Fourth, the validity of the life event measures to accurately assess events in the first 16 years of life is unknown. Fifth, it is important in future research to include other indicators of psychopathology (eg, anxiety disorders) and potentially relevant dimensions (eg, adjustment) to delineate and validate profiles.

Some implications for treatment and future research can be drawn from these findings. First, the binge-purge AN group was the only eating disorder group to appear uniquely in LP4. The placement of this eating disorder exclusively in this group may indicate that persons with this diagnosis do not experience mild forms of eating problems, consistent with previous findings.<sup>36</sup> Second, given that 50% of the women with lifetime AN in LP4 did not report the presence of amenorrhea, these results support the idea that amenorrhea is not required to meaningfully distinguish clinically significant AN.<sup>37</sup>

Third, disorders in which bingeing or purging occurs in the absence of other behaviors (EDNOS) should be given greater prominence in the DSM classification system. Further research is required with respect to the various types of EDNOS so that we can better understand their clinical significance.

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## REFERENCES

- Williamson DA, Gleaves DH, Stewart TM. Categorical versus dimensional models of eating disorders: an examination of the evidence. *Int J Eat Disord.* 2005; 37:1-10.
- Fairburn CG, Bohn K. Eating disorders NOS (EDNOS): an example of the troublesome "not otherwise specified" (NOS) category in *DSM-IV*. *Behav Res Ther.* 2005; 43:691-701.
- Goodman LA. Exploratory latent structure analysis using both identifiable and unidentifiable models. *Biometrika.* 1974;61:215-231.
- Duncan AE, Neuman RJ, Kramer J, Kuperman S, Hesselbrock V, Reich T, Buchholz KK. Are there subgroups of bulimia nervosa based on comorbid psychiatric disorders? *Int J Eat Disord.* 2005;37:19-25.
- Sullivan PF, Bulik CM, Kendler KS. The epidemiology and classification of bulimia nervosa. *Psychol Med.* 1998;28:599-610.
- Striegel-Moore RH, Franko DL, Thompson D, Barton B, Schreiber GB, Daniels SR. An empirical study of the typology of bulimia nervosa and its spectrum variants. *Psychol Med.* 2005;35:1563-1572.
- Keel PK, Fichter M, Quadflieg N, Bulik CM, Baxter MG, Thornton L, Halmi KA, Kaplan AS, Strober M, Woodside DB, Crow SJ, Mitchell JE, Rotondo A, Mauri M, Cassano G, Treasure J, Goldman D, Berrettini WH, Kaye WH. Application of a latent class analysis to empirically define eating disorder phenotypes. *Arch Gen Psychiatry.* 2004;61:192-200.
- Bulik CM, Sullivan PF, Kendler KS. An empirical study of the classification of eating disorders. *Am J Psychiatry.* 2000;157:886-895.
- Fairburn CG, Cooper Z. The Eating Disorder Examination. In: Fairburn CG, Wilson GT, eds. *Binge Eating: Nature, Assessment and Treatment*. 12th ed. New York, NY: Guilford Press; 1993:317-360.
- Heath AC, Howells W, Kirk KM, Madden PAF, Bucholz KK, Nelson EC, Slutske WS, Statham DJ, Martin NG. Predictors of non-response to a questionnaire survey of a volunteer twin panel: findings from the Australian 1989 twin cohort. *Twin Res.* 2001;4:73-80.
- Wade T, Tiggemann M, Abraham S, Heath A, Treloar SA, Martin N. The structure of disordered eating in a female twin population. *Int J Eat Disord.* 1996;19:63-71.
- Keel PK, Mayer SA, Harnden-Fischer JH. Importance of size in defining binge-eating episodes in bulimia nervosa. *Int J Eat Disord.* 2001;29:294-301.
- Binford RB, le Grange D. Adolescents with bulimia nervosa and eating disorder not otherwise specified—purging only. *Int J Eat Disord.* 2005;38:157-161.
- Keel PK, Haedt A, Edler C. Purging disorder: an ominous variant of bulimia nervosa? *Int J Eat Disord.* 2005;38:191-199.
- Wade TD, Bergin JL, Tiggemann M, Bulik CM, Fairburn CG. Prevalence and long-term course of lifetime eating disorders in an adult Australian twin cohort. *Aust N Z J Psychiatry.* 2006;40:121-128.
- Rosenberg M. *Society and the Adolescent Self-Image*. Princeton, NJ: Princeton University Press; 1960.
- Barratt ES. Anxiety and impulsiveness related to psychomotor efficiency. *Percept Mot Skill.* 1959;9:191-198.
- Frost RO, Marten P, Lahart C, Rosenblate R. The dimensions of perfectionism. *Cognit Ther Res.* 1990;14:449-468.
- Moos RH. *Family Environment Scale*. Mountain View, Calif: Consulting Psychologists Press; 1974.
- Fairburn CG, Welch SL, Doll HA, Davies BA, O'Connor ME. Risk factors for bulimia nervosa: a community-based case-control study. *Arch Gen Psychiatry.* 1997; 54:509-517.
- Bucholz KK, Cadoret R, Cloninger CR, Dinwiddie SH, Hesselbrock VM, Nurnberger JI, Riech T, Schmidt F, Shuckitt MA. A new, semi-structured psychiatric interview for use in genetic linkage studies: a report on the reliability of the SSAGA. *J Stud Alcohol.* 1994;55:149-158.
- Lazarfeld PF, Henry NW. *Latent Structure Analysis*. Boston, Mass: Houghton Mifflin Co; 1968.
- Muthén LK, Muthén BO. *Mplus User's Guide: Statistical Analysis With Latent Variables*. Los Angeles, Calif: Muthén & Muthén; 2004.
- Sclove S. Application of model selection criteria to some problems in multivariate analysis. *Psychometrika.* 1987;52:333-343.
- Cassin SE, von Ranson KM. Personality and eating disorders: a decade in review. *Clin Psychol Rev.* 2005;25:895-916.
- Kendler KS, Gardner CO. Boundaries of major depression: an evaluation of *DSM-IV* criteria. *Am J Psychiatry.* 1998;155:172-177.
- Heath AC, Bucholz KK, Slutske WS, Madden PAF, Dinwiddie SH, Dunne MP, Statham DB, Whitfield JB, Martin NG, Eaves LJ. The assessment of alcoholism in surveys of the general community: what are we measuring? some insights from the Australian twin panel interview survey. *Int Rev Psychiatry.* 1997;6:295-307.
- Milos G, Spindler A, Schnyder U, Fairburn GG. Instability of eating disorder diagnoses: prospective study. *Br J Psychiatry.* 2005;187:573-578.
- Fairburn CG, Welch SL, Norman PA, O'Connor ME, Doll HA. Bias and bulimia nervosa: how typical are clinic cases? *Am J Psychiatry.* 1996;153:386-391.
- Brown WJ, Bryson L, Byles JE, Dobson AJ, Lee C, Mishra G. Women's Health Australia: recruitment for a national longitudinal cohort study. *Women Health.* 1998;28:23-40.
- Hay P. Quality of life and bulimic eating disorder behaviours: findings from a community-based sample. *Int J Eat Disord.* 2003;33:434-442.
- Wade T, Tiggemann M, Martin NG, Heath AC. Characteristics of interview refusers: women who decline to participate in interviews relating to eating. *Int J Eat Disord.* 1997;22:95-99.
- Wade TD, Bulik CM, Kendler KS. Reliability of lifetime history of bulimia nervosa: comparison with major depression. *Br J Psychiatry.* 2000;177:72-76.
- Rice JP, Rochberg N, Endicott J, Lavori PW, Miller C. Stability of psychiatric diagnoses: an application of the affective disorders. *Arch Gen Psychiatry.* 1992; 49:824-830.
- Field AE, Colditz GA, Herzog DB, Heatherton TF. Disordered eating: can women accurately recall their bingeing and purging behaviours 10 years later? *Obes Res.* 1996;4:153-159.
- Kahn C, Pike KM. In search of predictors of drop-out from inpatient treatment of anorexia nervosa. *Int J Eat Disord.* 2001;30:237-244.
- Garfinkel PE, Lin E, Goering P, Spegg C, Goldbloom DS, Kennedy S, Kaplan AS, Woodside DB. Should amenorrhoea be necessary for the diagnosis of anorexia nervosa? evidence from a Canadian community sample. *Br J Psychiatry.* 1996; 168:500-506.