RESEARCH ARTICLE

Do Recognizable Lifetime Eating Disorder Phenotypes Naturally Occur in a Culturally Asian Population? A Combined Latent Profile and Taxometric Approach

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Abstract

Background: We examined whether empirically derived eating disorder (ED) categories in Hong Kong Chinese patients ($N = 454$) would be consistent with recognizable lifetime ED phenotypes derived from latent structure models of European and American samples.
Method: We performed latent profile analysis (LPA) using indicator variables from data collected during routine assessment, and then applied taxometric analysis to determine whether latent classes were qualitatively versus quantitatively distinct.
Results: Latent profile analysis identified four classes: (i) binge/purge (47%); (ii) non-fat-phobic low-weight (34%); (iii) fat-phobic low-weight (12%); and (iv) overweight disordered eating (6%). Taxometric analysis identified qualitative (categorical) distinctions between the binge/purge and non-fat-phobic low-weight classes, and also between the fat-phobic and non-fat-phobic low-weight classes. Distinctions between the fat-phobic low-weight and binge/purge classes were indeterminate.
Conclusion: Empirically derived categories in Hong Kong showed recognizable correspondence with recognizable lifetime ED phenotypes. Although taxometric findings support two distinct classes of low weight EDs, LPA findings also support heterogeneity among non-fat-phobic individuals. Copyright © 2015 John Wiley & Sons, Ltd and Eating Disorders Association.

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DSM-5; fat phobia; anorexia nervosa; latent profile analysis; taxometric analysis

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The recently published *DSM-5* includes multiple revisions to the domain now comprising Feeding and Eating Disorders (ED; American Psychiatric Association, 2013). Notable *DSM-5* changes include modifications of anorexia nervosa (AN) and bulimia nervosa (BN) criteria to encompass a greater proportion of cases previously classified as ED not otherwise specified (now other specified feeding or ED). One such AN change operationalizes criterion B to include explicit endorsement of fat phobia and/or engagement in persistent behaviour that maintains low weight (e.g., restrictive eating and excessive physical activity; Becker, Eddy, & Perloe, 2009a). Another noteworthy change was the addition of binge ED (BED) as a new diagnostic category, and the relocation of avoidant/restrictive food intake disorder (ARFID; a category amended from feeding disorder of infancy and early childhood) to the *DSM-5* chapter on feeding and EDs. The central feature of ARFID is 'persistent failure to meet appropriate nutritional and/or energy needs' in the absence of the body image disturbance that characterizes AN (American Psychiatric Association, 2013, p. 334).

Although *DSM-5* revisions were undertaken to enhance clinical utility by drawing from empirical data, critics (Fairburn & Cooper, 2011) have expressed concern that the majority of ED patients exhibit 'mixed' presentations that do not closely resemble the previous *DSM-IV* or newly revised *DSM-5* diagnoses. Another potential challenge in evaluating *DSM-5* revisions is the differential diagnosis of individuals who might plausibly fit into more than one category. For example, low-weight ED patients who minimize or deny the shape and weight concerns that *DSM-IV* previously defined as the *sine qua non* of AN have been identified around the globe (including the US, Canada, Europe, Asia and the

Pacific Islands; Becker, Thomas, & Pike, 2009b). This group also comprises approximately 20% of low-weight patients in North American ED specialty clinics (Ramacciotti et al., 2002; Strober et al., 1999) and is thought to be even more common in culturally Asian populations, such as the Hong Kong Chinese (Lee et al., 2001). In lieu of expressing or endorsing fat phobia, such patients may say that they 'don't know' why they are underweight (Lee et al., 2001), or alternatively, attribute their caloric restriction to a non-weight-related rationale—such as religious asceticism (Banks, 1996), gastrointestinal discomfort (Lee et al., 2001) or need for control (Fairburn et al., 1998). It is unclear whether such individuals would be most appropriately categorized in *DSM-5* as AN, ARFID, or other specified feeding or ED. Contemporaneously with *DSM-IV*, this group received multiple ad-hoc diagnostic labels, including 'non-fat-phobic AN' (Lee et al., 1993), 'low-weight ED without over-evaluation of shape and weight' (Dalle Grave et al., 2008), and 'AN without drive for thinness' (Abbate-Daga et al., 2007). Moreover, the distinction (if any) between this group and 'food avoidance emotional disorder' (loss of interest in feeding resulting in significant weight loss in young children, now subsumed under ARFID; Nicholls & Bryant-Waugh, 2009) is inadequately understood.

Validating *DSM-5* diagnoses in diverse samples is important, because just 6% of papers published in top psychiatry journals emanate from countries outside of Western Europe, North America, Australia or New Zealand, which collectively represent more than 90% of the world's population (Patel & Sumathipala, 2001). Moreover, cross-cultural differences in ED phenotypes—particularly the non-fat-phobic AN observed in Asia (Lee et al., 1993) and Africa (Bennett et al., 2004)—highlight the need to include non-Caucasian participants in nosologic research.

One analytic strategy that has helped to clarify bounds between ED presentations—and therefore, facilitated the evaluation of proposed revisions in the run-up to *DSM-5*—is latent profile analysis (LPA). LPA is a technique that uses maximum likelihood estimation to assign participants to mutually exclusive populations called latent classes. By empirically deriving clinical groupings based on real-world data, LPA offers an empirical strategy for comparing the relative correspondence of clinical reality with *DSM-5* categories. In the years leading up to *DSM-5*, LPA played a critical role in the validation of BED as a syndrome distinct from BN (Bulik et al., 2000; Pinheiro et al., 2008; Striegel-Moore et al., 2005). In contrast, fewer LPA studies have generated data pertaining to the role of fear of weight gain in AN. While several LPAs have identified subgroups of low to normal weight individuals who exhibit mild to moderate weight concerns (Dechartres et al., 2011; Eddy et al., 2009; Eddy et al., 2010; Keel et al., 2004; Keel et al., 2011; Mitchell et al., 2007; O'Toole et al., 2011), only two have identified a subgroup clearly resembling non-fat-phobic AN, in which shape and weight concerns are essentially absent (Crow et al., 2012; Wildes et al., 2013). For example, in Crow et al. (2012), the majority of members in one latent class had a body mass index (BMI) below 19.0 kg/m^2 but did not endorse fear of weight gain. Notably, this class exhibited a higher mortality rate than the other five classes, supporting the clinical significance—and potential severity—of a non-fat-phobic ED presentation.

Because LPA is unable to determine whether the resulting latent classes are truly discrete (i.e., versus the same underlying disorder at differing degrees of psychopathology; Crosby et al., 2011), more recent investigations (Keel et al., 2011; Eddy et al., 2011) have conducted subsequent taxometric analyses (TA) of observed LPA classes. Meehl's (1995) taxometric method is designed to determine whether two putative groups do indeed differ categorically, as opposed to constituting dimensional variation along one or more continua, such as shape/weight concerns.

Therefore, the purpose of the present study was to determine how closely naturally occurring ED phenotypes in a culturally Asian population would resemble recognizable lifetime ED phenotypes, such as those described in newly revised *DSM-5* categories. To do this, we conducted a sequential LPA and TA of selected feeding and ED symptoms in a large sample of patients who presented for treatment at one of two outpatient mental health clinics in Hong Kong from 1984 to 2009. Based on prior clinical observations, we hypothesized that empirically derived symptom clusters would be roughly consistent with broad *DSM-IV*/*DSM-5* phenotypes (i.e., AN and BN), and that a phenotype resembling the recently established *DSM-5* category of BED would also emerge as a distinct latent class. Based on well-documented differences in course, outcome and treatment response across *DSM-IV* EDs, we further hypothesized that the distinction among these LPA-derived classes would be categorical rather than dimensional when examined using TA. Of particular interest in this culturally Asian sample was the empirical classification of the subset of low-weight patients who minimize or who do not endorse or articulate shape and weight concerns (Lee et al., 2001; Lee *et al.*, 1993). If this group either merged into an overarching AN-like class or emerged as its own latent class that was continuous with another low-weight class, this would provide potential support for *DSM-5* AN criterion B to encompass non-fat-phobic presentations. If, however, a non-fat-phobic group emerged as its own class that was categorically distinct from a more AN-like low-weight class, this could be interpreted as support for the addition of a distinct feeding or ED—such as ARFID.

Method

Patient sample

This study comprised a secondary data analysis of 595 ED patients evaluated between 1984 and 2009 at one of two outpatient mental health clinics affiliated with the Faculty of Medicine at The Chinese University of Hong Kong. Patients were eligible for inclusion in the analytic sample for the present study if they provided complete data on each of the LPA indicators selected for this study and were women (because amenorrhea, which is of interest as a former diagnostic criterion for *DSM-IV* AN, could not be assessed in men). Of ED patients consecutively evaluated at these two clinics during the study recruitment period, 454 (76.3%) met inclusion criteria for the present study. These patients were primarily single, in their early twenties, and either employed or enrolled in school. The average ED duration at the time of the evaluation was 3 years. Demographic and clinical characteristics of the sample are presented in Table 1. The Clinical Research Ethics Committee at The Chinese University of Hong Kong approved the original data collection at Hong Kong-based clinics, and the Partners Human Research Committee at Massachusetts General Hospital approved the secondary data analysis for the present study.

Table 1 Demographic and clinical characteristics of 454 female eating disorder treatment-seekers in Hong Kong

	M (*SD*)
Age at consultation (years)	22.43 (6.29)
Body mass index (kg/m^2)	18.45 (4.45)
Length of Illness (years)	2.98 (3.20)
	n (%)
Eating Disorder Diagnosis (*DSM-IV* or *DSM-III-R*)	
Anorexia Nervosa	207 (45.6%)
Bulimia Nervosa	223 (49.1%)
Eating Disorder Not Otherwise Specified	24 (5.3%)
Marital status	
Single	419 (92.3%)
Married or cohabitating	35 (7.7%)
Education	
Primary	4 (0.9%)
Secondary	288 (63.4%)
Undergraduate	154 (33.9%)
Postgraduate	8 (1.8%)

Clinical assessment

The 1984 initiation of data collection in the current sample predated the routine use of structured interviews for ED diagnoses. Clinicians instead conferred ED diagnoses during unstructured clinical interviews in which they queried current diagnostic criteria (i.e., either *DSM-III-R* or *DSM-IV*) at the time of the evaluation. The clinical interview was based on Dr. Sing Lee's experience with ED patients and research using *DSM* criteria. Prior research has demonstrated adequate inter-rater reliability between structured and unstructured interviews for ED diagnoses in specialty clinics (e.g., $k = 0.70$, 80% agreement, in Thomas et al., 2010). Patients' height and weight were measured and recorded during the consultation and later used to calculate BMI. We utilized absolute BMI (rather than BMI centile) because the majority (78%) of participants were over 18 (mean = 22.43 years, $SD = 6.29$), and absolute BMI could be applied uniformly to all patients within the same analysis. In addition to answering questions about disordered eating attitudes and behaviours, each patient was asked to state her desired body weight (i.e., the body weight she personally preferred, regardless of the opinions of her family members or doctor).

A non-random convenience subset of patients also completed the Eating Disorder Examination-Questionnaire (EDE-Q; Fairburn & Beglin, 1994; $n = 86$, 14.5%) and Eating Disorders Inventory (EDI; Garner et al., 1983) Drive for Thinness subscale ($n = 251$, 42.2%). Because EDE-Q and EDI data were not available for the whole sample, we did not use them as LPA indicator variables, but rather, we used them to validate our proxy for fear of weight gain in a sample that overlapped with the analytic sample for the present study. Patients who exhibited low body weight and amenorrhea received a clinical diagnosis of AN, even if they did not explicitly endorse fear of weight gain and body image disturbance (Lee et al., 2001; Lee et al., 1993). Non-underweight patients who exhibited objectively large binge episodes, compensatory behaviours, and undue influence of weight and shape on self-evaluation received a diagnosis of BN. Lastly, patients with clinically significant EDs who did not meet criteria for either AN—as operationalized in this study—or BN, received diagnoses of ED not otherwise specified.

Latent profile analysis

Latent profile analysis relies on maximum likelihood estimation to separate a heterogeneous set of cases into homogeneous subsets called latent classes. Classes are called latent because they are not directly observable, but rather, they are defined by inter-correlations among observable variables of interest called indicator variables. The optimal number of latent classes in an LPA solution minimizes indicator variability within groups and maximizes indicator variability between groups, so that the resulting solution identifies the smallest number of mutually exclusive subgroups that could plausibly account for the observed inter-correlations among indicator variables.

Latent profile analysis indicator variables

Because the present study was designed to empirically evaluate ED diagnostic categories, our LPA indicator variables comprised clinical data that could best support evaluation of *DSM-IV*/*DSM-5* diagnostic criteria for AN and BN. These included the following: (i) current BMI (measured continuously as kg/m^2); (ii) lifetime presence of amenorrhea (yes/no); (iii) lifetime presence of any binge eating (yes/no); (iv) lifetime presence of any self-induced vomiting (yes/no); (v) lifetime presence of any laxative use (yes/no); and (vi) current desire for a higher BMI.

Rationale and operationalization of a proxy for absence of intense fear of weight gain

In the present study, we conceptualized 'desire for a higher BMI' as a proxy for the *absence* of 'intense fear of gaining weight or becoming fat… even though at a significantly low weight' (American Psychiatric Association, 2013, p. 338), in the absence of complete case data on conventional assessment for AN criterion B. We calculated current BMI from each patient's height and weight at the first consultation, and desired BMI by asking each patient the body weight that she personally preferred, regardless of the opinion of others, and recorded height at first consultation. We operationalized desire for a higher BMI for LPA analyses as follows: 'present' if the patient's desired BMI was greater than her current BMI and 'absent' if the patient's desired BMI was less than her current BMI. Each of the 454 subjects provided data that allowed assignment to one of these two categories. In order to examine the validity of this proxy, we examined its concurrent validity with two known constructs assessing fear of weight gain in the subset of the sample for which these data were also available. These proxies included the Eating Disorder Inventory Drive for Thinness subscale (Garner et al., 1983) and the EDE-Q item 'Over the past four weeks, have you had a definite fear of gaining weight?' (Fairburn & Beglin, 1994). Supporting the use of our construct as a valid proxy for the absence of fear of weight gain, we found that individuals who desired a higher BMI scored more than one standard deviation lower, on average, on both EDI Drive for Thinness ($t[227] = 9.26$, $d = 1.22$, $p < .001$) and EDE-Q fear of weight gain ($t[47.67] = 4.86$, $d = 1.14$, $p < .001$), compared with those who desired a lower BMI.

We conducted our LPA using Latent Gold 4.5 (Vermunt & Magidson, 2005). Although multiple fit indices have been purported to identify the optimal number of latent classes in an LPA model, the Bayesian information criterion (BIC) consistently outperforms other fit indices in Monte Carlo simulations and is currently the most widely used (Nylund et al., 2007). Therefore, in the present study, we identified the class solution associated with the lowest value of BIC (indicating the smallest discrepancy between predicted and observed values) as well as the minimization of each individual's cross-classification probability (defined as the likelihood that an individual would have an equal probability of being assigned to two or more latent classes). We examined bivariate residuals (indices of the remaining associations among pairs of indicator variables within latent classes, calculated as the chi square of observed versus model-predicted counts, divided by degrees of freedom) to ensure that none were greater than 3.0.

Taxometric analysis

Taxometric analyses were used to evaluate whether the identified latent classes differed dimensionally or categorically. Analyses were conducted in R using a suite of programmes developed by Ruscio (2012). Consistent with recommendations in the taxometrics literature (Beauchaine, 2007; Meehl & Yonce, 1994; Meehl & Yonce, 1996; Ruscio et al., 2006; Waller & Meehl, 1998), we applied multiple procedures and examined the convergence of results across procedures (Ruscio et al., 2010).

In TA, we used the six indicators included in the LPA, such that we had two continuous variables—BMI, and current desire for a higher BMI (operationalized as the absolute difference between current and desired weight in pounds)—and four categorical variables—lifetime history of amenorrhea, binge eating, self-induced vomiting and laxative use). We used desire for a higher BMI continuously in the TA (versus dichotomously in the LPA). This is because Monte Carlo simulations have suggested that, when only two indicators are available for TA (as was the case for some of our comparisons), it is important that each indicator vary across as many values as possible (Ruscio et al., 2011). After standardizing the six indicators, we ran descriptive statistics and pairwise comparisons on all six indicators for the identified LP classes. Indicators were included in subsequent taxometric analyses if they showed validities (Cohen's d of > 1.2), suggesting adequate distinction between the putative taxon and complement (Meehl, 1995; Beauchaine & Beauchaine, 2002). Next, we bootstrapped sampling distributions of taxometric results by analyzing simulated taxonic and dimensional comparison data sets (Ruscio et al., 2007). Specifically, we generated large (but finite; $N = 100\,000$) populations of categorical and dimensional comparison data that reproduce the characteristics of the empirical data (e.g., number of variables as well as their marginal distributions and inter-correlations). From each of these populations, 100 random samples were drawn such that their size matched the empirical data. Finally, all of these bootstrap samples were submitted to the same taxometric analyses as the empirical data.

For each unique pairwise comparison between latent classes, each indicator set was submitted to up to three taxometric procedures: mean above minus below a cut (Meehl & Yonce, 1994), maximum eigenvalue (Waller & Meehl, 1998) and latent mode factor analysis (Waller & Meehl, 1998). Both the comparison curve fit index (CCFI; Ruscio et al., 2007) and the generated plots were examined to determine the presence of categories versus dimensions. The CCFI evaluates the fit between the curves generated by the data, compared with those curves that would be expected were the data to be either categorical or dimensional. This index is interpreted such that CCFI < 0.45 is suggestive of dimensionality, CCFI > 0.55 is suggestive of taxonicity, and $0.45 \leq$ CCFI ≤ 0.55 is considered to be ambiguous and therefore, cannot be determined as either dimensional or categorical. Plots were rated by an investigator (Dr. Kamryn Eddy) with training in recognizing categorical, dimensional, and ambiguous curves and reviewed by a co-author with extensive experience in TA (Dr. John Ruscio).

The use of three taxometric procedures allows for examination of convergence of findings across non-redundant data-analytic techniques. Consistency checks are a cornerstone of Meehl's (1995) taxometric method, and an emerging body of evidence provides strong support for the operationalization of 'consistency' using CCFIs provided by multiple taxometric procedures. In the most extensive of several Monte Carlo studies, the mean of several taxometric procedures' CCFI values yielded an accuracy rate of 99% when implemented as in the present study (Ruscio et al., 2010).

Results

Latent profile analysis

We evaluated models with one to six classes. To meet the assumptions of the LPA model, we allowed for the conditional dependence of one pair of indicator variables that was highly correlated in our sample: history of self-induced vomiting and history of binge eating. The BIC was lowest for a four-class model with 31 parameters. The relative endorsement of indicator variables in each of the four latent classes is displayed in Table 2.

The largest class (47.4%, $n = 215$) featured bingeing and purging at normal weight, and therefore resembled BN; for shorthand ease of interpretation, we named this the 'binge/purge class'. Nearly all members of this class (97%) engaged in binge eating. Self-induced vomiting (51%) was common, and some class members engaged in laxative use (37%), for a total of 69% engaging in at least one purging behaviour. Mean BMI (20.47 kg/m^2) was within the normal range. No members of this class expressed a desire to gain weight, preferring a BMI that was, on average, 2.35 points lower than their current BMI (desired BMI = 18.12 kg/m^2).

In contrast, the second largest class (33.7%, $n = 153$) featured the lowest BMI (14.14 kg/m^2) of all four classes. Members of this class uniformly endorsed a desire for higher BMI (desired BMI = 17.15 kg/m^2), that was, on average, 3.01 points higher than their current BMI. The vast majority of class members had amenorrhea (95%). However, they were less likely than members of other classes to engage in binge eating (32%) or compensatory behaviours [such as vomiting (10%) or laxative use (12%)]. We named this group the 'non-fat-phobic low-weight class'.

In contrast, the third class (12.3%, $n = 56$) resembled classic AN; we refer to this group as the 'fat-phobic low-weight class'. The majority of class members were underweight (mean BMI = 16.86 kg/m^2) and amenorrheic (82%), and were more likely than members of the other low-weight class to engage in binge eating (64%), vomiting (37%) and laxative use (32%).

Table 2 Prevalence of eating disorder symptom endorsement across the four latent classes

	Binge/purge Class ($n = 215$)	Non-fat-phobic low-weight class ($n = 153$)	Fat-phobic low-weight class ($n = 56$)	Overweight disordered eating class ($n = 30$)
BMI				
Mean (SD) kg/m^2	20.47 (1.86)	14.14 (1.64)	16.86 (1.33)	28.99 (4.28)
Amenorrhea				
No	100 (47%)	8 (5%)	10 (18%)	**17** (**57**%)
Yes	**115** (**53**%)	**145** (**95**%)	**46** (**82**%)	13 (43%)
Binge Eating				
No	6 (3%)	**104** (**68**%)	20 (36%)	0 (0%)
Yes	**209** (**97**%)	49 (32%)	**36** (**64**%)	**30** (**100**%)
Self-induced vomiting				
No	105 (49%)	**138** (**90**%)	**35** (**63**%)	**19** (**63**%)
Yes	**110** (**51**%)	15 (10%)	21 (37%)	11 (37%)
Laxative use				
No	**135** (**63**%)	**135** (**88**%)	**38** (**68**%)	**26** (**87**%)
Yes	80 (37%)	18 (12%)	18 (32%)	4 (13%)
Desires higher BMI				
No	**215** (**100**%)	0 (0%)	28 (50%)	**30** (**100**%)
Yes	0 (0%)	**153** (**100**%)	28 (50%)	0 (0%)
Desired BMI				
Mean (SD) kg/m^2	18.12 (1.34)	17.15 (1.59)	16.98 (1.80)	20.78 (1.90)

Note: BMI, body mass index. Within each cell, the bold percentage indicates the modal response for that variable within that latent class. Desired BMI was not used as an indicator in the latent profile analysis.

Indeed, more than half (54%) engaged in one or more compensatory behaviours (e.g., either vomiting, laxative use or both). Perhaps most notably, members of this fat-phobic low-weight class were less likely than members of the other low-weight class to desire a higher BMI (50%). On average, members of this class preferred to remain at a weight close to their currently low BMI (mean desired—current BMI = 0.12; desired BMI = 16.98 kg/m^2).

The last and smallest class (6.6%, $n = 30$) included overweight patients (BMI = 28.99 kg/m^2) all of whom engaged in binge eating and desired a lower BMI (mean discrepancy = −8.21). Notably, this mean desired BMI (20.78 kg/m^2) falls into the normal range for adults: neither underweight nor overweight. Fewer than half (43%) of participants engaged in compensatory behaviours such as vomiting (37%) or laxative use (13%). We refer to this group as the 'overweight disordered eating class'.

Taxometric analyses

The results of taxometric analyses are displayed in Figures 1–3. Comparisons between the binge/purge and non-fat-phobic low-weight classes, and between the fat-phobic and non-fat-phobic low-weight classes, were both strongly supportive of categorical distinctions (mean CCFI = 0.847 for binge/purge vs. non-fat-phobic low-weight; mean CCFI = 0.663 for fat-phobic low-weight vs. non-fat-phobic low-weight). Analyses comparing the binge/purge class to the fat-phobic low-weight class were indeterminate (mean CCFI = 0.482). The overweight disordered eating class was not included in the taxometric analyses due to its small sample size ($n = 30$), which could have yielded spurious findings regarding categorical/dimensional distinctions (see Ruscio & Walters, 2011 for sample size and other data requirements and implementation decisions in TA).

Discussion

Overall, empirically derived latent classes from our Hong Kong sample showed substantial correspondence with recognizable lifetime ED phenotypes, including those described in *DSM-5* and identified in previous latent structure models. Our findings are therefore consistent with previous LPA studies in culturally Western and primarily Caucasian samples that have identified classes resembling AN (Bulik et al., 2000; Dechartres et al., 2011; Keel et al., 2004), BN (Bulik et al., 2000; Pinheiro et al., 2008; Striegel-Moore et al., 2005; Eddy et al., 2009; Keel et al., 2004; Sullivan et al., 1998), and BED (Bulik et al., 2000; Pinheiro et al., 2008; Striegel-Moore et al., 2005), although our simultaneous application of current and lifetime symptoms as LPA indicators prevents us from evaluating perfect correspondence. Interestingly, the fat-phobic low-weight and overweight disordered eating groups are consistent with recent observations that the clinical features of EDs in Hong Kong are becoming increasingly similar to those observed in Western countries (Lee et al., 2010). Indeed, recent epidemiological work has highlighted high levels of body dissatisfaction among Hong Kong adolescents, due in part to sociocultural influences that prioritize thinness (Lai et al., 2013). However, the non-fat-phobic low-weight group is consistent with previous descriptions of this phenotype cross-culturally (Becker et al., 2009b) and highlights the importance of including non-Caucasians in nosologic research.

Our indeterminate taxometric distinction between the fat-phobic low-weight and binge/purge classes is consistent with previous indeterminate (Keel et al., 2011; Gleaves et al., 2000) and non-categorical (Olatunji et al., 2012) taxometric findings, and may reflect the shared psychopathology (Fairburn et al., 2003) and/or temporal fluidity (Eddy et al., 2008; Nevins et al., 2012) between AN and BN. Moreover, binge/purge symptoms were

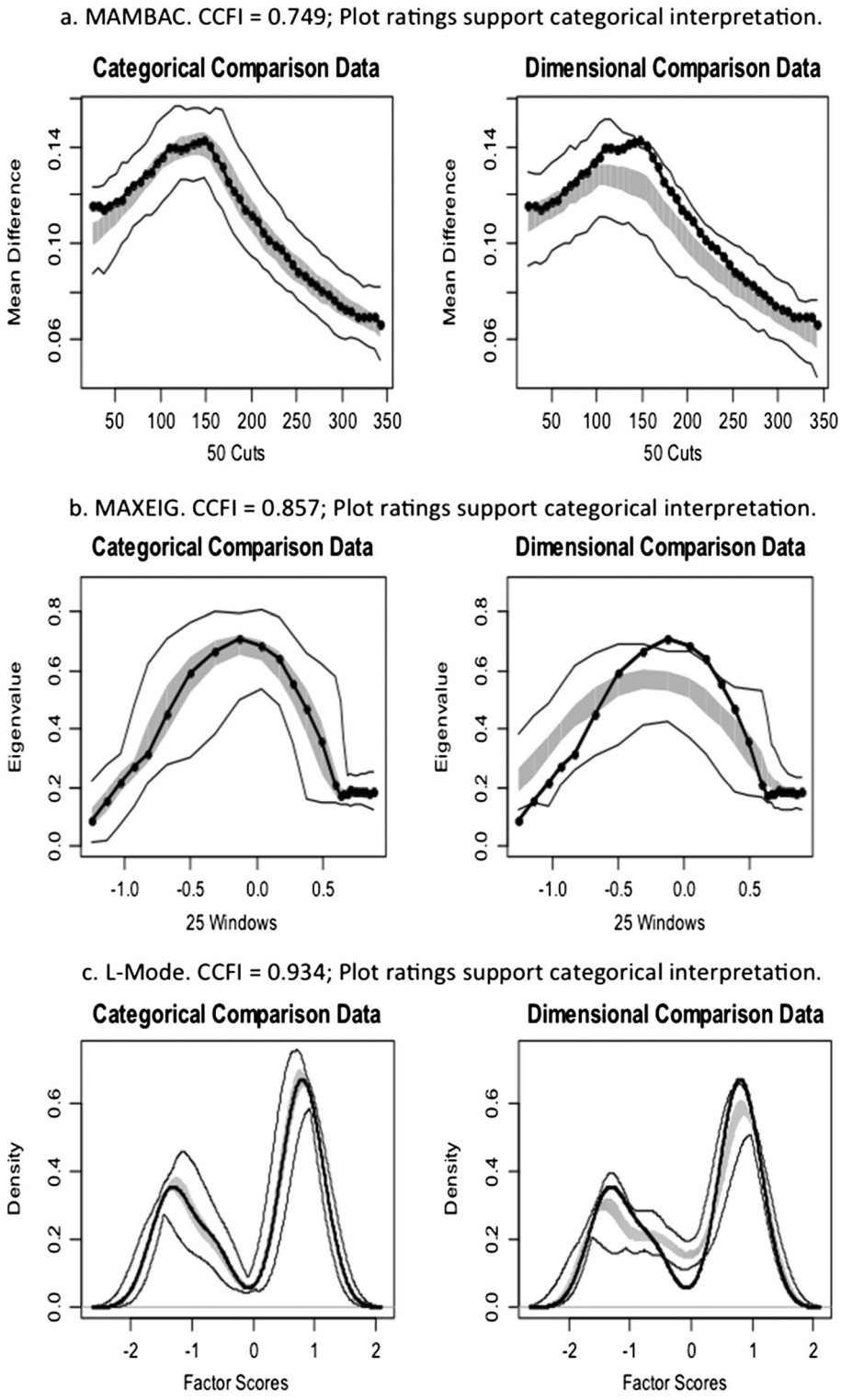

Figure 1. Taxometric analyses of binge/purge and non-fat-phobic low-weight classes across panels (a)–(c). Mean CCFI = 0.847; final interpretation is categorical. CCFI, comparison curve fit index; MAMBAC, mean above minus below a cut; MAXEIG, maximum eigenvalue; L-mode, latent mode

present in both low-weight classes (although more prominent in the fat-phobic class, in keeping with previous findings, Becker et al., 2009b), providing limited support for *DSM-5* AN subtypes. Taken together, these findings provide additional support for the *DSM-5* retention of AN and BN as broad syndromes with validity across at least two distinctive cultural contexts.

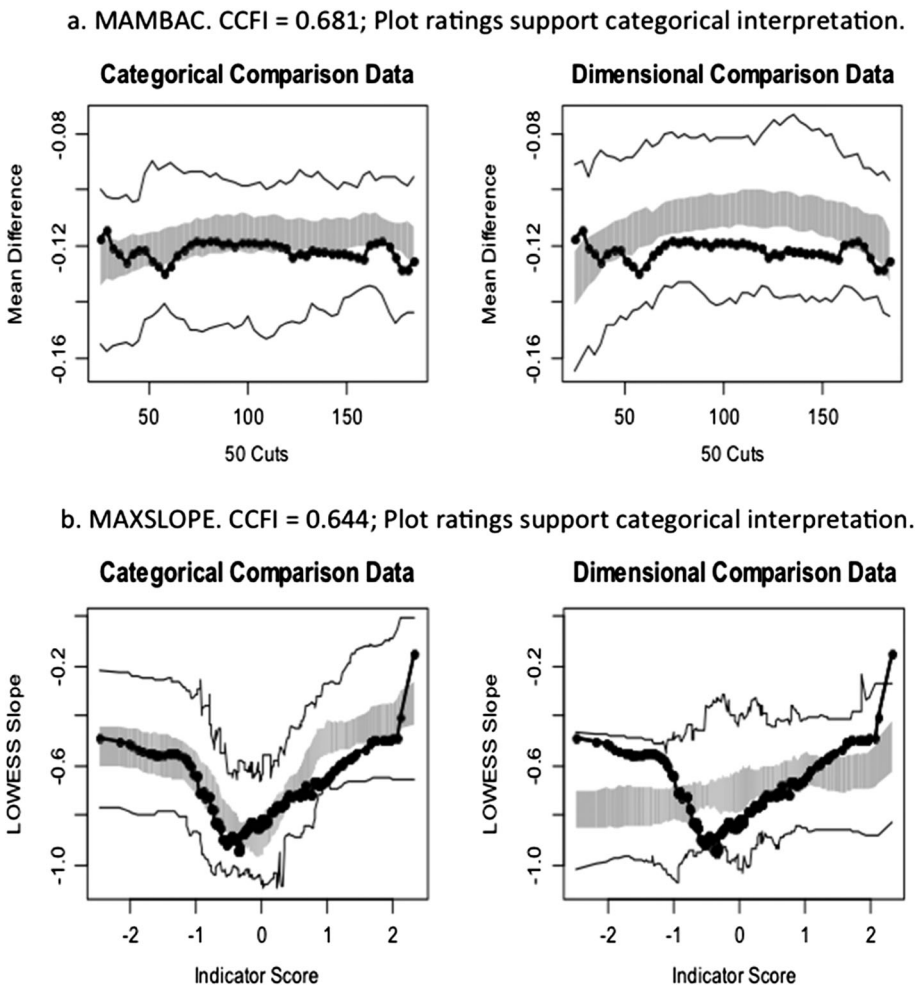

Figure 2. Taxometric analyses of non-fat-phobic and fat-phobic low-weight classes across panels (a)–(b). Mean CCFI = 0.663; final interpretation is categorical. CCFI, comparison curve fit index; MAMBAC, mean above minus below a cut

The identification of a low-weight, amenorrheic group that would not clearly meet *DSM-IV* AN criterion B ('fear of weight gain') is consistent with the LPA findings of Crow et al. (2012) and Wildes et al. (2013), as well as clinical reports of non-fat-phobic AN in culturally Asian populations (Becker et al., 2009b; Lee et al., 1993). Although this non-fat-phobic low-weight class was not readily represented in *DSM-IV*, *DSM-5* provides at least two classification options.

First, the non-fat-phobic low-weight class could plausibly fit into *DSM-5* AN, which no longer requires patients to endorse fear of weight gain if they exhibit repeated behaviours that impede weight gain. The small subset of this class (20%) who reported a history of either vomiting, laxative abuse or both, would potentially have met the revised AN criterion B. For the remaining 80% of class members, the apparent desire for higher BMI could have been an artefact of superficial compliance or extremely low BMI at presentation. Because previous research has identified that individuals with AN can express different and even multiple rationales for food restriction over the course of their illness (Ngai et al., 2000; Wildes et al., 2013), the possibility that fat phobia would emerge during future nutritional rehabilitation cannot be ruled out. Moreover, if members of the non-fat-phobic low-weight class ultimately reached their desired BMI, they still would have weighed less than the average contemporaneous Miss Hong Kong beauty pageant contestant (18.24 kg/m^2; Leung et al., 2001), suggesting that their standards of thinness were even more stringent than one proxy for the societal ideal. Interestingly, the non-fat-phobic low-weight class preferred a BMI (17.15 kg/m^2) that was close to the preferred BMI of the fat-phobic low-weight class (16.98 kg/m^2), highlighting the similarity between the two groups.

A second *DSM-5* classification possibility for the non-fat-phobic low-weight class is ARFID, a feeding disorder characterized by failure to meet nutrition or energy needs in the absence of shape and weight concerns. Data to support this interpretation are class members' desire for a BMI approximately three BMI points higher than current BMI, and their relatively low endorsement of purging behaviours. Indeed, the categorical taxometric distinction between this class and the fat-phobic low-weight class suggests that the optimal *DSM* classification scheme would place

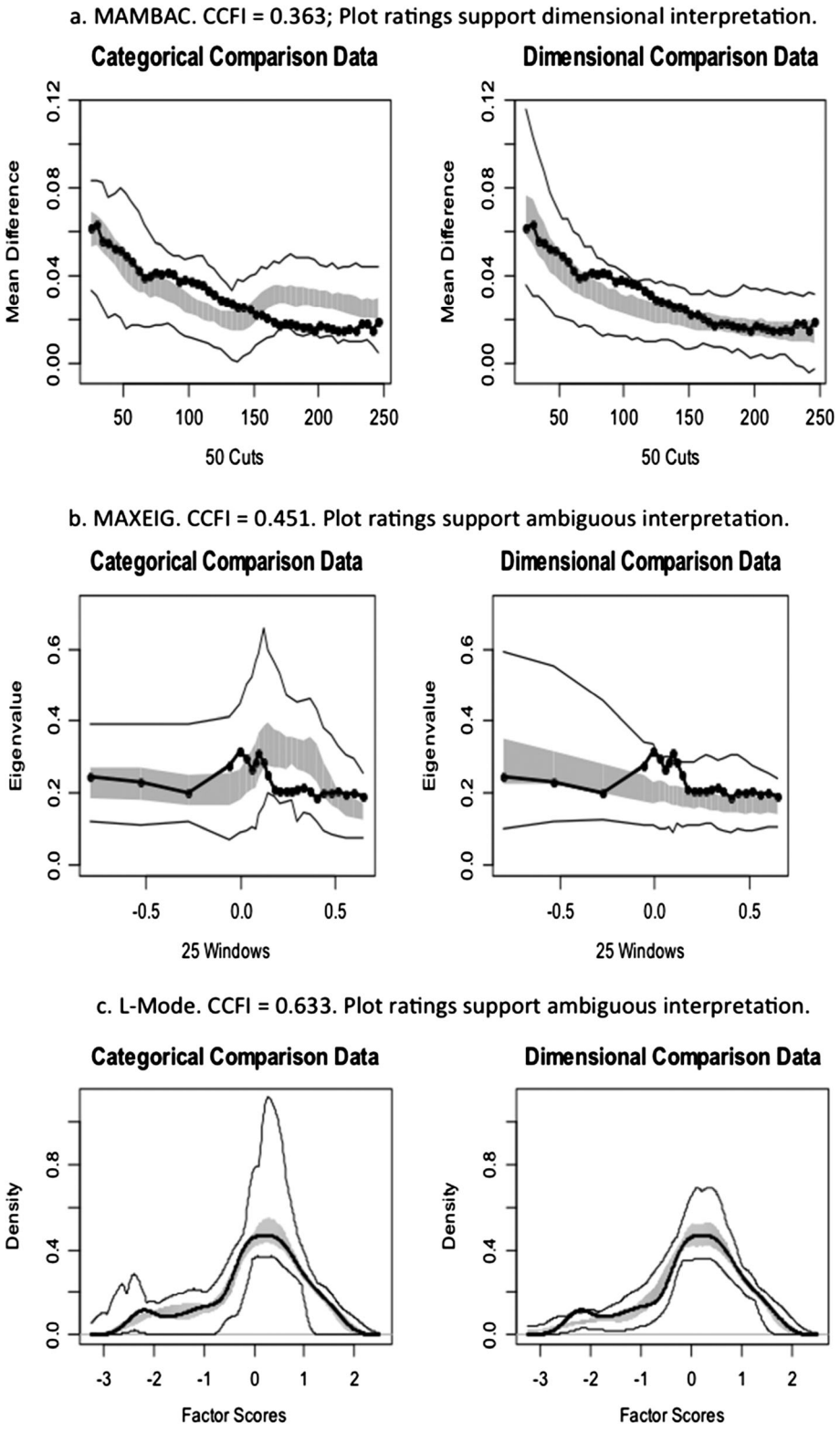

Figure 3. Taxometric analyses of binge/purge and fat-phobic low-weight classes across panels (a)–(c). Mean CCFI = 0.482; final interpretation is ambiguous. CCFI, comparison curve fit index; MAMBAC, mean above minus below a cut; MAXEIG, maximum eigenvalue; L-mode, latent mode

these two presentations in separate diagnostic categories. Of course, using this logic, a subset of the fat-phobic low-weight class who desired weight gain and lacked evidence of purging (46%) could also potentially be classified as ARFID. Unfortunately, we did not have self-report or behavioural data available on all diagnostic constructs relevant to new criteria for *DSM-5* AN (e.g., persistent behaviours interfering with weight gain and lack of recognition of the seriousness of low weight), ARFID (e.g., lack of interest in feeding) or non-purging BN (e.g., fasting and compensatory exercise). As the ED field moves forward with *DSM-5* changes, investigators must rise to the challenge of updating long-held measures of ED psychopathology (e.g., the EDE and EDI) to capture newly revised diagnostic constructs (Thomas, Roberto, & Berg, 2013). Future work should investigate whether these constructs, and/or the egosyntonicity or acknowledgement of functional impairment associated with low weight could help further differentiate ARFID from *DSM-5* AN. Notably, our study uses a novel approach to complement previous findings that non-fat-phobic AN may represent a phenomenologically heterogeneous group; further, this study extends our previous understanding of non-fat-phobic AN in suggesting potentially clinically salient distinctions across these phenotypes.

The categorical distinction between the non-fat-phobic and fat-phobic low-weight classes is consistent with the findings of Keel et al. (2011), who also identified a taxonic relationship between a fat-phobic low-weight class and a non-weight-phobic (albeit normal-weight) group. In this regard, our data add to an emerging body of research supporting the clinically meaningful heterogeneity of weight concerns among individuals with EDs. The optimal clinical understanding of non-fat-phobic low-weight patients—and the corresponding classification of this population in future editions of *DSM*—will require improvements in both measurement paradigms and study design. Specifically, more sensitive measures of fat phobia that carefully consider the role of implicit cognitions (Thomas, Hartmann, & Killgore, 2013), current low body weight and the appropriateness of desired weight (Chernyak & Lowe, 2010) on the ascertainment of fat phobia are needed. Moreover, the collection of corroboratory behavioural, collateral and longitudinal data (Becker et al., 2009b) will help evaluate the impact of socially desirable responding and clarify whether non-fat-phobic presentations are qualitatively distinct or merely prodromal ED presentations that evolve into typical AN during the process of nutritional rehabilitation.

With regard to the final latent class, the finding that 43% of patients in the overweight disordered eating class endorsed purging behaviours was surprising as it diverges somewhat from *DSM-5* categorization, which classifies purging and non-purging binge-eating syndromes into BN versus BED, respectively. Instead, in our study, the binge/purge and overweight disordered eating classes were differentiated primarily by BMI. This suggests that higher-weight individuals with BN were grouped together with BED in the overweight disordered eating class, and/or that individuals who crossed over between BN-like and BED-like presentations (Fichter & Quadflieg, 2007) during the course of the study composed a portion of this class. The changing 'weightscape' of BN has been observed previously (Bulik et al., 2012; Jordan et al., 2014) and has implications for clinical care, especially when legitimately overweight patients uniformly express a desire for a lower BMI, as in the current LPA. Unfortunately, small sample size precluded us from evaluating whether the distinction between these two classes was categorical versus dimensional.

Our findings should be interpreted carefully in light of the following limitations. First, we operationalized fear of weight gain as the relative difference between current and desired BMI (as calculated from measured height and weight and self-reported desired weight), and we did not have specific data on either body image disturbance or overvaluation of weight and shape. We also acknowledge that absent desire for weight gain is likely to have different clinical significance in normal-weight and overweight patients versus underweight patients. Nonetheless, we maintain that this proxy had reasonable construct validity in this sample, given its correlation, in a non-random convenience subset of the sample, with similar known constructs (EDI Drive for Thinness and EDE-Q Fear of Weight Gain) that are widely used to define fear of weight gain in research and clinical practice. Second, because of changes in data collection practices over the 15-year recruitment period, we did not have sufficient data on potential external validators (e.g., eating pathology, general psychopathology, biomarkers and treatment outcome) to compare across latent classes. Future research is needed in order to determine the extent to which the four empirically derived classes identified by this study may differ in these important domains. Third, a limitation of our TA was the relatively few indicators available to distinguish putative taxa from their complements, which may have contributed to the indeterminate distinction between the fat-phobic low-weight and binge/purge classes. Fourth, the use of lifetime (rather than current) ED symptoms as LPA indicators limited our ability to assess latent class correspondence with *DSM-5* categories, which are based on current symptoms only. For example, the presence of lifetime purging in a substantial portion of the overweight disordered eating class would decrease *DSM-5* correspondence if the purging was concurrent with the binge eating but would be consistent with the diagnostic fluidity between BN and BED (Stice et al., 2009) if the purging pre-dated the binge-eating. Similarly, because only categorical data were available on certain symptoms (e.g., lifetime binge eating rather than current frequency), we could not use as indicators the *DSM-5* threshold frequencies for disordered eating behaviours. Lastly, because our sample came from a special administrative region of just one Asian country, our findings will not necessarily generalize to other non-Western populations. Relatedly, although the distinction we identified between the fat-phobic and non-fat-phobic low-weight classes replicates two previous US-based studies (Crow et al., 2012; Wildes et al., 2013), its generalizability across other Western populations is unknown.

In conclusion, the results of our sequential LPA and TA approach suggest that the diversity of ED presentations among Hong Kong treatment-seekers can be classified into recognizable lifetime ED phenotypes that correspond somewhat more closely to *DSM-5* (which includes BED and allows diverse rationales for food restriction in AN) than *DSM-IV* categories (which do not). However, our findings highlighted a low-weight, non-fat-phobic ED phenotype that is qualitatively distinct

from typical AN. The optimal classification of this group as either *DSM-5* AN, ARFID, or otherwise will require that future research employ more sensitive and contextualized measures of fat phobia and collect behavioural, collateral and longitudinal data.

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