•ORIGINAL RESEARCH ARTICLE•

The Latent Class Structure of Chinese Patients with Eating Disorders in Shanghai

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Background: Eating disorder is culture related, and the clinical symptoms are different between eastern and western patients. So the validity of feeding and eating disorders in the upcoming ICD-11 guide for Chinese patients is unclear.

Aims: To explore the latent class structure of Chinese patients with eating disorder and the cross-cultural validity of the eating disorder section of the new ICD-11 guide in China.

Methods: A total of 379 patients with eating disorders at Shanghai Mental Health Center were evaluated using the EDI questionnaire and a questionnaire developed by researchers from 2010 to 2016. SPSS 20.0 was used to enter data and analyze demographic data, and Latent GOLD was employed to conduct latent profile analysis.

Results: According to the results of latent profile analysis, patients with eating disorder were divided into five classes: low-weight fasting class (23.1%), non-fat-phobic binge/purge class (21.54%), low-fat-phobic binge class (19.27%), fat-phobic binge class (19.27%), and non-fat-phobic low-weight class (16.76%). Among the clinical symptoms extracted, there were significant differences in Body Mass Index (BMI), binge eating behavior, self-induced vomiting, laxative use and fat-phobic opinion; while there was no significant difference in restrictive food intake.

Conclusions: Based on the clinical symptoms, there are five latent classes in Chinese patients with eating disorder, which is in accordance with the diagnostic categories of feeding and eating disorder in ICD-11. However, further work is needed in improving the fat-phobic opinion of patients with eating disorder and clarifying the BMI standard of thinness in the Chinese population.

Key words: eating disorders; latent class modeling; ICD-11; anorexia nervosa

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1. Introduction

Eating disorder (ED) is referred to as a syndrome characterized by unusual eating behavior and psychological disturbance, and accompanied with significant weight change and physiological dysfunction.[1] Currently, the main references for the diagnosis of this illness are the International Classification of Diseases and Related Health Problems, 10th Revision (ICD-10) and the Diagnostic and Statistical Manual of Mental Disorders, fifth Edition (DSM-V). Recently, the ICD-11 has been completed with an estimated publication date of 2018.[2] The eating disorder classifications were changed from ICD-10 to ICD-11, including adding the diagnoses of Avoidant/Restrictive Food Intake Disorder (ARFID) and Binge Eating Disorder (BED), and revising the diagnostic criteria for Anorexia Nervosa (AN) and Bulimia Nervosa (BN).[3]

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When it comes to international guides, the cross-culture validity of diagnostic criteria needs to be considered.[4] As a culture related disorder, the clinical symptoms of eastern and western patients with eating disorder are different. Ever since Li and colleagues reported on Non-fat phobic anorexia nervosa (NF-AN) patients among those with eating disorders in Hong Kong,[5] a series of studies about non-western eating disorder patients have been conducted, and the questions related to whether or not NF-AN should be included in the diagnostic guide have been raised.[6]

In recent studies of the diagnostic classifications of eating disorder, latent class clustering has been the most frequently-used analysis method.[7] Latent class clustering reveals the latent classes within a group by classifying together those subjects who are highly similar. The results of this statistical method can be used to validate classifications of the current diagnostic guide (ICD-11). Based on the results of several international studies, the classifications include AN-like group, BN-like group and BED-like group, which provides evidence supporting AN and BN classifications in the ICD-10 and BED classification in the ICD-11.[7] Additionally, a few studies also reported the existence of a low-fat-phobic low-weight group.[8,9] However, most studies are still focused on western patients, while there is no current classification for mainland Chinese patients with eating disorder. The newest classification study on eating disorder patients in Hong Kong also focused on the diagnostic problem of NF-AN patients,[10] however there were some limitations in this study. First, evaluating an individuals' fat-phobia using the difference between ideal weight and current weight (i.e. if the ideal weight is smaller than the current weight, fat-phobia opinion is present) does not apply to patients whose current weights are much smaller than the normal standard, and this result will be directly affected by patient weight changes. Secondly, the morbidity of eating disorder has been steadily increasing in China over the past few decades, and the morbidities of different sub-types have been changing as well;[11] but as a retrospective study, the time span of the sample is too long (1984-2009) to present the constitution of the current eating disorder classification well.

Therefore, the present study analyzes the classification of clinical symptoms of Chinese patients with eating disorder, discusses the clinical symptoms of different sub-types, compares the classification and diagnostic criteria of feeding and eating disorders in ICD-11, and provides evidence for these classifications in the ICD-11, as well as suggestions on how to apply ICD-11 in China.

2. Methods

2.1 Participants

The participants were recruited from eating disorder outpatients and inpatients at Shanghai Mental Health Center from 2010 to 2016. Inclusion criteria: (1) patients who met the diagnostic criteria for an eating disorder according to the DSM-IV as assessed by two senior level psychiatrists; (2) age 13 and above; (3) having the ability to understand and complete the questionnaires; (4) any patients who had severe neurological disorders, medical conditions or other mental disorders and could not comprehend or complete the questionnaires were excluded. A total of 379 cases were collected. All participants were first-time patients at the Shanghai Mental Health Center and were in a current episode of eating disorder. More details about the participants is discussed in the results section.

This study followed the ethical standards protocol set by the Ethics Committee of the Shanghai Mental Health Center. Written informed consent was provided by participants or by the parents of those participants who were under 18.

2.2 Assessment

2.2.1 General demographic questionnaire

This questionnaire was developed by the researchers, including study ID, name, gender, age, occupation, marital status, education level, height, weight, body mass index (BMI), the age of onset, the total duration of illness, triggering events for current episode, current diagnosis, and record of weight loss-causing behavior.

#### 2.2.2 Drive for Thinness (DT) of Eating Disorder Inventory (EDI-I)

EDI-I was written by Garner and colleagues in 1983, and it was the first self-rating eating disorder questionnaire introduced into China. ED comprises 64 questions divided into 8 subscales: drive for thinness, body dissatisfaction, bulimia, perfectionism, interpersonal distrust, maturity fears, introspective awareness, and ineffectiveness. The drive for thinness questionnaire can indicate the prognosis for an eating disorder, and it was used to reflect the fat-phobic opinions of patients. The 7 questions in this subscale are on a 6-point scale: always, usually, often, sometimes, occasionally, and never, with values as 3, 3, 3, 2, 1, and 0 respectively. The summation of all items' scores is the total score. The higher the total score is, the more likely one is to have an eating disorder.[12] Chinese researchers have adapted and translated this scale. The validity and reliability of this scale has been tested among female college students in Mainland China, young Chinese women in Hong Kong and with patients with AN (with good reliability and validity).[13,14,15]

2.3 Study process

2.3.1 Diagnosis

Participants in this study were diagnosed by two senior level psychiatrists and divided into either the AN group, BN group or eating disorder Not Otherwise Specified group.

Figure 1. Flowchart of the study
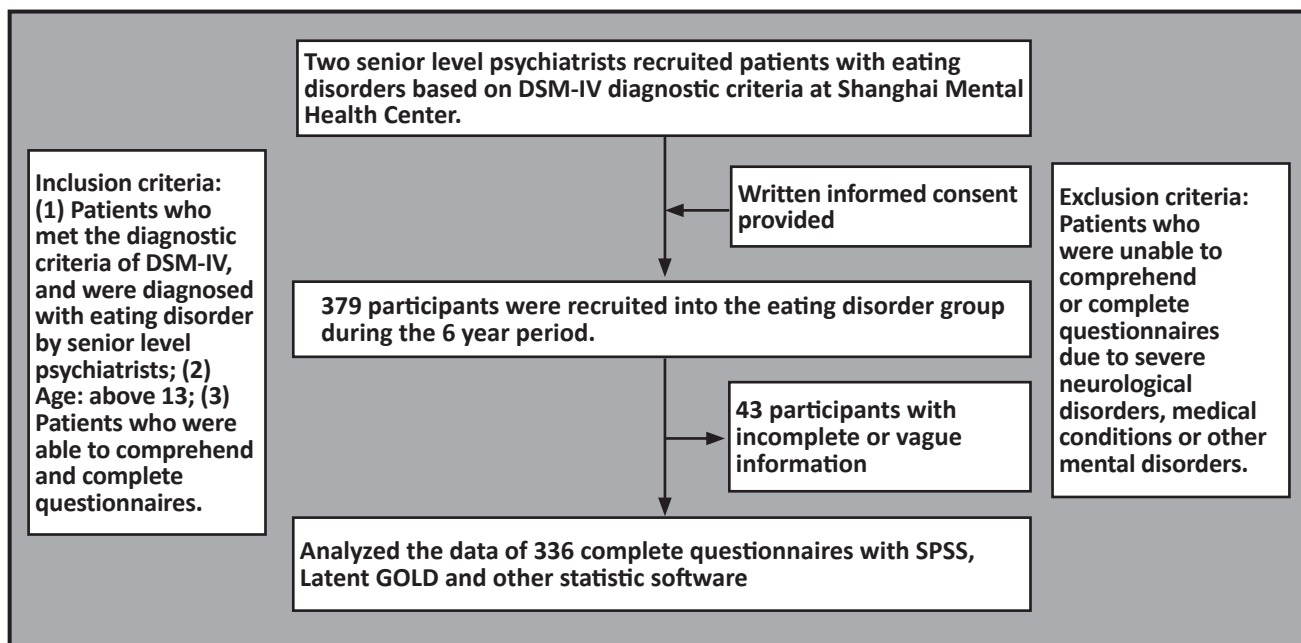
2.3.2 Quantitative statistics

Data was analyzed using SPSS 20.0. Latent profile analysis was conducted using Latent GOLD 4.5 software. Data regarding age when treatment began and age of onset did not have a normal distribution therefore they were described using median. BMI had a normal distribution therefore mean (SD) was used.

Because the above mentioned studies in China did not include latent profile analysis we chose to use exploratory latent profile analysis to further analyze the variables related to eating disorder.[15] The process of latent profiling analysis is the following: (1) estimation of the initial model (i.e., assuming only one class exists in the assumed group); (2) gradually adding the number of classes, estimating the parameters of every model, and calculating suitability; (3) comparing different models with the fitting evaluation index and selecting the most fitted one; (4) naming different classes, and organizing the results of parameter estimation.[16]

2.3.3 Model evaluation and selection

The frequently-used fitting parameters in latent profiling analysis include: Bayesian Information Criterions (BIC)[17] and consistent Akaike Information Criterion (cAIC).[18] The smaller both of these parameters are, the more fitting the model is. Most empirical studies employ BIC as the model fitness index, and select the model with the smallest BIC as the most fitting one.[19] The present study used BIC as the model fitness index, and also selected models with bivariate residual values below 3.0 to ensure the explanatory power of the model. Bivariate residual value represents the relevance between two

variables in one latent class; and the bigger this value is, the more relevant the two variables are. Besides the indexes described above, the present study also considered the realistic meaning of the classifications and the sample size of each classification before the classification model was finalized.

3. Results

3.1 Demographic data

There were 336 (88.7%) effective questionnaires (324 females and 12 males) out of a total of 379 participants interviewed. The demographic data of the participants are displayed in Table 1. Educational level of the participants was the following: elementary school 5 (1.5%), junior high 61 (18.2%), high school 111 (33.1%), college undergraduate 146 (43.6%), and postgraduate 12 (3.6%). Participants median age 16 (range: 7 – 31). The median duration of illness was 18 months (range: 1-192 months). The mean (sd) for BMI was 16.45 (2.92) (range: 10.85-27.34). According to the diagnostic criteria of DSM-IV, there were 107 (31.8%) participants with AN (restrictive type), 101 (30.1%) participants with AN (binge eating/purging type), 92 (27.4%) participants with BN, and 36 (10.7%) participants with eating disorder Not Otherwise Specified.

3.2 Latent profiling analysis

According to the latent fitness indexes, BIC and cAIC values were lowest when 5 classes were kept, which supported the selection of this model. This model comprised 44 parameters.

Table 1. Demographic characteristics of 366 eating disorder patients at Shanghai Mental Health Center		
	Values	**Number of patients (n=336)**
BMI; Mean (Standard deviation)	16.45 (2.92)	
Age of treatment; median (minimum, maximum)	19 (11, 36)	
Age at onset of illness; median (minimum, maximum)	16 (7, 31)	
The classification of diagnoses (based on DSM-IV) (n%)		
Anorexia nervosa (restricting type)		108 (32.1%)
Anorexia nervosa (purging type)		100 (29.8%)
Bulimia nervosa		92 (27.4%)
Eating disorder; unspecified		36 (10.1%)
Education level (%)		
Elementary school		5 (1.5%)
Junior high		61 (18.2%)
High school		111 (33.1%)
Undergraduate		146 (43.6%)
Postgraduate		12 (3.6%)

Based on the 6 indicator variables shown in Figure 2 and the conditional probabilities of different variables shown in Table 2, we named and described 5 classes as below:

(1) Low-weight fasting class (n=78, 23.1%): patients in this class had low BMI (14.64 kg/m^2) with restrictive food intake (85%) caused by fat-phobic opinions (DT=9.25), occasionally had self-induced vomiting (23%) and laxative use (13%), but rarely had any bulimia behavior (2%).

(2) Non-fat-phobic binge/purge class (n=72, 21.54%): patients in this class barely had any fat-phobic ideas (DT=0.12), and their BMIs were close to the normal standard (17.82 kg/m^2). They had bulimia behavior (92%) and purging behavior, including self-induced vomiting (74%) and laxative use (29%). The incidence of restrictive food intake (81%) was the lowest of all five classes.

(3) Low-fat-phobic binge class (n=65, 19.27%): BMIs of patients in this class were close to the normal standard (17.88 kg/m^2), and bulimia behavior (92%) was present. Some patients had purging behavior, including self-induced vomiting (54%) and laxative use (14%). The incidence rate of restrictive food intake (92%) was the highest of all five classes. The fat-phobic ideation level was low (DT=5.51)

(4) Fat-phobic binge class (n=65, 19.27%): patients in this class had close to normal BMI (17.52 kg/m^2) Most patients had bulimia behavior (75%) and restrictive food intake (82%), while some patients had self-induced vomiting (51%) and laxative use (28%). The fat-phobic level was high (DT=16.86)

(5) Non-fat-phobic low-weight class (n=56, 16.76%): patients in this class had the lowest BMI (14.28 kg/m^2) of all five classes. Most patients had restrictive food intake (89%), while only a few patients had bulimia (14%). Self-induced vomiting (3%) and laxative use (4%) was rarely present. Patients had almost no fat-phobic ideation (DT=0.18).

The results of the six variables' regression analysis in five classes (see Table 3) indicated that BMI was 29.91% explained by five classes significantly (Wald=36.19, $p<0.001$), and this deviation could be explained effectively by latent classes. Besides this, the deviations of Bulimia (Wald=36.19, $p<0.001$), Self-induced vomiting (Wald=34.42, $p<0.001$), Laxative use (Wald=11.13, $p<0.05$) and Fat-phobic ideation (DT) (Wald=932.99, $p<0.001$) were explained effectively by latent classes as well. Results were statistically significant. In contrast, the results of Restrictive food intake (Wald=2.93, $p=0.571$) was not significant, indicating that it could only be 1.34% explained by the five classes.

4. Discussion

4.1 Main findings

The results of the present study of Chinese patients with eating disorder are in accordance with the diagnostic criteria in the new ICD-11. Specifically, the first class meets the diagnostic criteria for AN (restrictive type),

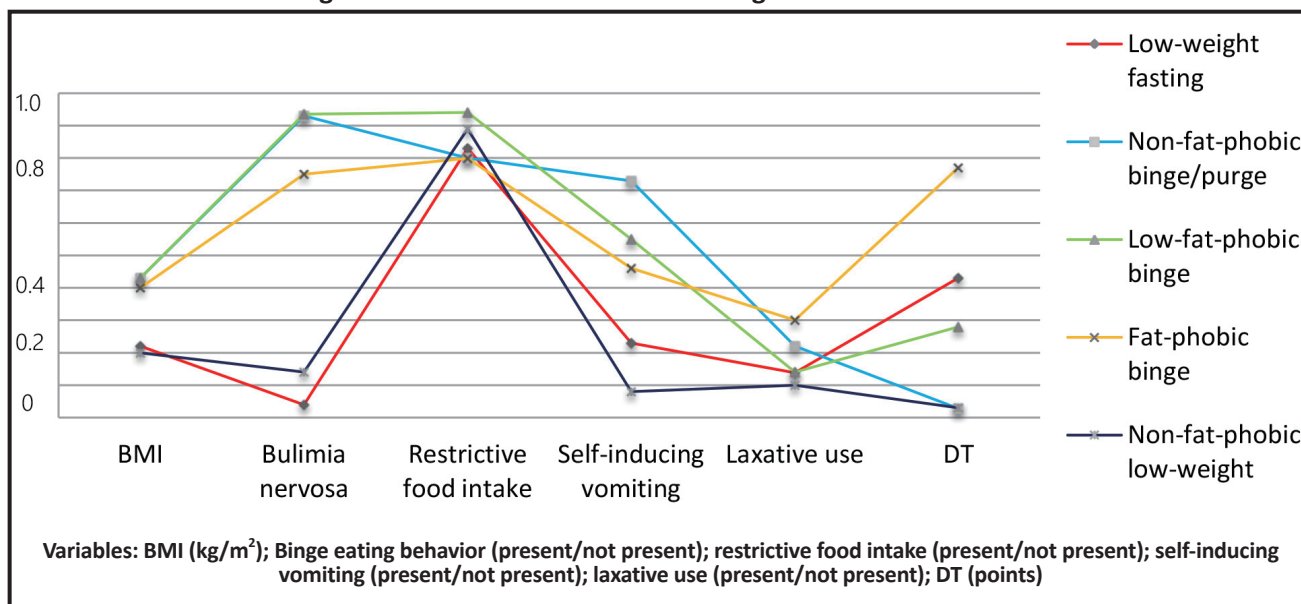**Figure 2. The indicator variables among the five latent classes**

Variables: BMI (kg/m^2); Binge eating behavior (present/not present); restrictive food intake (present/not present); self-inducing vomiting (present/not present); laxative use (present/not present); DT (points)

Table 2. Prevalence of eating disorder symptoms among the five latent classes

	Low-weight fasting group	Non-fat-phobic binge/purge group	Low-fat-phobic binge group	Fat-phobic binge group	Non-fat-phobic low-weight group
	N=78	N=72	N=65	N=65	N=56
BMI					
M (SD) kg/m^2	14.64(1.94)	17.82 (2.41)	17.88 (3.30)	17.52(2.47)	14.28 (1.72)
Binge eating					
Not present	77(98%)	6(8%)	5(8%)	16(24%)	48 (86%)
Present	1(2%)	66(92%)	60(92%)	49(75%)	8(14%)
Restrictive food intake					
Not present	12(15%)	14(19%)	5(8%)	12(18%)	6(11%)
Present	66(85%)	58(81%)	60(92%)	53(82%)	50(89%)
Self-induced vomiting					
Not present	60(77%)	19(26%)	30(46%)	32(49%)	53(95%)
Present	18(23%)	53(74%)	35(54%)	33(51%)	3(5%)
Laxative use					
Nor present	68(87%)	51(71%)	56(86%)	47(72%)	52(93%)
Present	10(13%)	21(29%)	9(14%)	18(28%)	4(7%)
Drive for thinness					
EDI scores M(SD)	9.14 (0.93)	0.12 (0.06)	5.51 (0.77)	16.88 (0.65)	0.18 (0.09)

Table 3. Regression analysis of the correlation coefficients of the five latent classes

	Wald	_p_-value	R^2
BMI	136.11	1.9e^{-28}	0.2991
Bing eating	36.19	2.6e^{-7}	0.6314
Restrictive food intake	2.93	0.571	0.0134
Self-induced vomiting	34.42	6.1e^{-7}	0.2246
Laxative use	11.13	0.025	0.0480
Fat-phobic (DT)	932.99	1.2e^{-200}	0.7762

and the third and the fourth classes meet the diagnostic criteria for BN, or BED or AN (binge eating/purging type); and the fifth class meets the diagnostic criteria for ARFID or other feeding and eating disorder.[3]

The possible reasons why the third and the fourth classes meet the diagnostic criteria of multiple disorders are listed below:

(1) Clinically speaking, BN and AN (binge eating/purging type) overlap in terms of the development and prognosis of the disease,[20] which indicates that they probably share the same psycho pathological factors.

(2) The critical difference between BN and AN (binge eating/purging type) is the low BMI cut-off point. As stated in previous studies, the Asian population's BMI level is lower than that of western populations.[21,22] However the diagnostic guide is still using the western low weight standard (18.5 kg/m^2) as the reference. If the cut-off point was lowered according to the low BMI level of the Chinese population, the third and the forth classes would be more inclined to the diagnostic criteria of BN and BED.

(3) BED is a new independent diagnosis from DSM-V, and the results of a number of internationally published latent class studies support this classification.[8,23] Currently, there is little research on these individuals in China, and clinically it is quite rare. Due to the lack of public knowledge surrounding this disorder, most patients with obesity probably seek treatment in endocrinology or digestive departments. In the sample of the present study, BED was not a separate class because the number of patients in this class was too small.

Among the five classes, only the second class Non-fat-phobic binge/purge class does not fall in any specific classification in ICD-11, so it was classified as other feeding and eating disorder.

However, if the criteria for fat-phobic ideation is relaxed, it means that any relevant behavior observed clinically (e.g. checking body shape frequently, checking weight repeatedly, or opposite behavior, such as avoidance of weighing machines, or mirrors or tight clothes) can represent patients hiding or failing to recognize their fat-phobic ideas. In this case, some patients who meet this description meet the diagnostic criteria for AN and BN. This modification has been shown in ICD-11. As stated in ICD-11 guide, "AN/BN patients' behaviors of losing or maintaining weight are usually driven by the drive for thinness or the strong fear of obvious weight gain. These behaviors can be evaluated to make the diagnosis even when patients do not give a clear indication regarding preoccupations with weight gain and body shape." Hence, clinical judgment regarding preoccupation with weight and body shape will decide whether patients are diagnosed with AN/BN or not.

This modification solves the diagnosis problem for some non-fat-phobic eating disorder patients, but it is still problematic. Specifically, the judgment on whether patients possess latent fat-phobic ideation or not is affected by the doctors' clinical experience, communications with patients, cultural environment and many other factors. Therefore, it can cause disagreements among evaluators, which undermines the credibility of the diagnosis.

Additionally, the results of the regression analysis on six clinical symptom variables demonstrate the different weights these symptoms hold in diagnostic classifications. Organized from large to small, they are: BMI, bulimia, fat-phobic opinion (DT), self-induced vomiting, laxative use and restrictive food intake. This order can provide references for clinical diagnostic processes. Restrictive food intake not being explained by the five classifications largely indicates that the differences of this variable among patients with eating disorder are insignificant. Even though restrictive food intake is an important index in eating disorder diagnosis, its value on differentiating sub-types of eating disorder is limited.

4.2 Limitations

The present study employed a cross-sectional retrospective design, so the data collected only reflected the situation at that moment. The symptoms collected, for instance, fat-phobic opinion or BMI, only reflected the conditions patients were in when they were admitted into the hospital; but these conditions may change later on. Patients may start to have fat-phobic ideas as they gained weight, or their diagnoses might change (e.g. the transformation between AN and BN), which could skew the results. In this retrospective study, how patients answered the questions might affect the results as self-rating questionnaires are the main tools of data collection. Additionally, lacking the objective indexes, such as biochemical variables and prognosis, the variables included are limited. In the meantime, as a regional study, this one was conducted in only one mental health institution. Therefore, this sample cannot represent all Chinese patients with eating disorder.

4.3 Implications

The present study is the first attempt to classify mainland Chinese eating disorder patients by their symptoms, and provide empirical evidence about the applicability of feeding and eating disorder in the upcoming ICD-11 guide. Based on the results, we give the following recommendations:

The classifications of Chinese eating disorder patients are basically in accord with the diagnostic classifications in the new ICD-11; however the fat-phobic standard of patients with eating disorder and the low BMI standard for the Chinese population need to be improved. Compared with the older version, the

current description of fat-phobic opinion in ICD-11 has improved significantly. Future research should focus on the relevant pathogeny to differentiate pathological and normal fat-phobic opinions. As for the low BMI standard, adults and teenagers are separated in ICD-11; teenagers' low weight conditions are evaluated with BMI-for-age.[3] But this evaluation method has not been used widely in China. While this evaluation method is being used in studies on teenagers, in order to ascertain specific data regarding the Chinese population's low BMI standard, studies should also focus on the distribution of BMI in Chinese adults.

Conflict of interest statement

Authors declare no conflict of interest related to this manuscript.

Informed consent

Written informed consent was provided by all participants and the parents of participants below 18.

Ethical approval

The present study was approved by the ethics committee of the Shanghai Mental Health Center.

Authors' contributions

Dr. Yuchen Zheng was in charge of designing and conducting this study, including data analysis, and writing of the article. Dr. Qing Kang and Jiabin Huang were responsible for collecting and entering data. Dr. Wenhui Jiang, Qiang Liu, Han Chen, Qing Fan and Zhen Wang were responsible for recruiting and diagnosing patients. Dr. Jue Chen recruited participants for this study and provided revision of the manuscript. Professor Zeping Xiao provided input on the study design and revision of the article.

上海进食障碍患者的潜在类别研究

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背景：进食障碍是一种文化相关疾病，东西方患者的临床表现有所不同，新版 ICD-11 指南即将出版，其喂养和进食障碍部分在中国进食障碍患者中的适用性尚不明确。

目的：探索中国进食障碍患者的潜在类别结构，研究新版 ICD-11 指南中进食障碍相关部分在中国的跨文化适用性。

方法：采用自制问卷和进食障碍问卷量表对 379 名 2010-2016 年于上海市精神卫生中心就诊的进食障碍患者的症状进行评估，使用 SPSS20.0 录入数据、处理人口学资料，通过 Latent GOLD 4.5 进行潜在剖面分析。

结果：依据潜在剖面分析结果可以将进食障碍分成：极低体重限制进食组（23.17%），无怕胖暴食清除组（21.54%），低水平怕胖暴食组（19.27%），怕胖暴食组（19.27%），极低体重无怕胖组（16.76%）。在提取的临床症状表现中，BMI、有无暴食行为、有无催吐、有无服用导泻剂及怕胖观念存在显著性差异，而有无限制性进食并无显著性差异。

结论：中国的进食障碍患者根据症状可以分成五个潜类别，基本符合 ICD-11 喂养和进食障碍的诊断分类。但进食障碍患者的怕胖观念标准和中国人群的低体重标准有待进一步完善。

关键词：进食障碍；潜类别模型；ICD-11；神经性厌食

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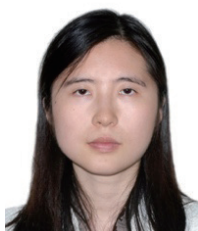
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