Localization of Intuitive Eating Scale-2 and Its Application in Chinese Obese Patients with Primary Hypertension

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Abstract

Intuitive eating (IE) is largely considered to be engaging in behaviors consistent with eating in reaction to one's physiological appetite and fullness signals instead of environmental stimuli and emotional cues. The Intuitive Eating Scale-2 (IES-2) was developed in order to assess the outlook and behaviors of eating on four subscales: unconditional permission to eat (UPE), eating because of physiological as opposed to emotional reasons (EPR), dependence on physiological hunger and satiety cues (RHSC), and body-food choice congruence (B-FCC). Obesity is a frequent comorbidity in Chinese patients with hypertension and nearly 3/4 of such patients have eating problems. The current study intended to validate the psychological measurement properties of the IES-2 Chinese Version (IES-2-Chi) in an obese population with hypertension. For the IES-2-Chi, Cronbach's α = 0.947, split-half reliability was 0.850, the test-retest reliability was 0.889, chi-square/degree of freedom ratio ($\chi 2/df$) = 1.318, root mean square error approximation (RMSEA) = 0.040, root mean square residual (RMR) = 0.053, goodness-of-fit index (GFI) = 0.902, comparative fit index (CFI) = 0.982, Tucker-Lewis index (TLI) = 0.978, incremental fit index (IFI) = 0.983, and normal fit index (NFI) = 0.932. The secondary study objective was to evaluate IE levels of obese Chinese patients with hypertension. IE was correlated positively with self-efficacy, body image, and frequency of eating vegetables and fruits, but negatively with body mass index, hemoglobin, diastolic blood pressure, hematocrit, total cholesterol, low-density lipoprotein, and frequency of eating fast food.

Conclusion: The current study demonstrates that the IES-2-Chi has good reliability and validity in obese patients with primary hypertension and can be used to evaluate IE levels of these patients. Based on the current study results, future studies may be designed to develop intervention strategies using IE to utilize its influential factors in obese patients with primary hypertension.

1. Introduction

Primary hypertension is a disease of polygenic inheritance, caused by genetic, environmental, and lifestyle factors. It is estimated that by 2025, there will be about 1.56 billion patients with hypertension globally, accounting for 29% of the adult population [1]. In China, there are currently about 200 million patients with hypertension, approximately equal to 1/5 of the global hypertensive population [2]. In recent years, hypertension has become a critical health issue with a continuous increase in morbidity, in part due to poor public awareness of prevention and control [3]. Drinking, mental stimulation, and obesity are generally regarded as risk factors for hypertension [4]. Obesity can increase the risk of hypertension by 7%-8% [5] and can greatly raise the risks of cardiovascular, metabolic, and renal diseases; meanwhile, it is also one of the most important and preventable causes for elevated blood pressure (BP) in patients with primary hypertension [6]. Several studies, however, have revealed that low dietary compliance is found in most patients with hypertension and obesity, with good dietary compliance only seen in 25% of the cases [7, 8]. Therefore, it is necessary to understand the eating behaviors of obese patients with primary hypertension, thereby providing a path to proper dietary guidance to help improve their health.

Environment and emotions are both contributors to human abnormal eating behaviors. Leslie et al. demonstrated that emotion can influence the eating behaviors of humans and that negative emotion may cause an increase in food intake. Some people know the effects of obesity on the physical profile, including BP and blood lipids and therefore maintain a diet of low-fat diet and controlled food intake to achieve their short-term goals of weight loss and lowering BP & blood lipids. After the dieting period, however, some experience weight gain due to a lack of control of eating behaviors, which sometimes includes over-eating and -drinking [9, 10, 11]. There are three psychological theories that try to explain abnormal eating at the etiological level: the psychosomatic theory, the exogenous theory, and the restrictive theory. The restrictive theory posits that strictly restraining the intake of calories or food types can change the dieting

recognition, such that individuals pay excessive attention to foods and lose control of their eating behaviors under emotional and external environmental stimuli, which has a positive correlation with obesity and over-drinking and -eating [12]. The psychosomatic theory, in contrast, proposes that abnormal eating is primarily caused by individual emotion, rather than attending to physical appetite and fullness signals [13]. Finally, the exogenous theory suggests that external environment stimuli (e.g., delicacies and eating with others) may weaken the sensitivity to hunger/satiety and arouse individual appetites, thereby causing excessive eating which can lead to health problems [14].

Tribole and Resch proposed a concept of intuitive eating (IE) and found that IE was a novel diet style that could be continued for a long time and can benefit one's physical and mental health [15]. IE integrates the concepts of external situations, emotional stimulation, physiological hunger, and satiety cues. Its key theory stipulates that individual's eating behaviors shall not be affected by situational or emotional stimuli, rather shall be guided by the body's physiological hunger and satiety cues. IE contains 10 principles [11]: (1) reject the diet outlook; (2) honor your hunger; (3) find harmony with food; (4) challenge the food police; (5) feel your satiety; (6) discover satisfaction; (7) respect your emotions in ways other than with food; (8) honor your body; (9) move your body, feeling the contrast; and (10) honor your health with kind nutrition. The latest study demonstrated that IE was inversely related to body mass index (BMI), cholesterol, and cardiovascular risks, but positively with irregular diet [16].

In 2004, Hawk et al. developed a scale containing 27 items to measure IE (intrinsic eating, extrinsic eating, anti-dieting, and self-care). The scale generally demonstrated good psychological measurement properties, but the IE subscale eating exhibited low internal consistency and test-retest reliability and the subscale of self-care failed to show the expected construct validity [17].

In 2006, Tylka complied another Intuitive Eating Scale (IES) [11]. This IES utilizes a three-factor model (unconditional permission to eat, eating for physical rather than emotional reasons, reliance on internal hunger/satiety cues) as opposed to Hawk's four-factor IES [10]. Most scholars currently agree that the IES developed by Tylka better reflects individual IE [12, 18, 19, 20].

Tylka and Kroon Van Diest (2013) created and validated the Intuitive Eating Scale-2 (IES-2) to address limitations of the IES [11]. Two primary changes were presented that update the next version of the IES-2. This construct was validated in women and men in a university population and an additional subscale was added, the body-food choice congruence subscale. This new subscale is significant as it offers an understanding of the individual's decisions that go into their choices of food. The IES-2, then, included and revised the four major sub-scales that are associated with intuitive eating from the first IES to: (1) eating because of physiological as opposed to emotional reasons; (2) unconditional permission to eat; (3) dependence on physiological hunger and satiety cues; and (4) body-food choice congruence. The IES-2 is a 23-item scale which is scored on a five-point Likert-type scale, with higher scores suggesting more intuitive eating behaviors. The IES-2 has revealed acceptable validity and reliability in several studies.

Current research

Some Chinese scholars have used the IES-2 in a cross-cultural adaptation and in an application of college students with good reliability and validity; however, there are currently no studies conducted in the clinical context. In an obese Chinese population with primary hypertension, the effectiveness and authenticity of the IES-2 are unknown. Therefore, the current study has the following objectives in obese Chinese patients with primary hypertension: 1) to localize the IES-2 and assess the reliability and validity of the IES-2 Chinese Version (IES-2-Chi); 2) to examine the relationship of IE with self-efficacy, body image, BMI, BP, laboratory values, and diet history; and 3) to analyze the influential factors for IE

and develop countermeasures for improving IE, thereby providing a reference for more effective dietary guidance in this population.

Study protocol

The IES-2 was translated and back-translated using Brislin's translation mode. The cross-cultural adaptation of the IES-2 translation was completed using both a pre-survey and having a discussion amongst an expert panel. A pre-survey of the IES-2 translation was first performed in an obese population with primary hypertension by utilizing a convenience sample to evaluate the reliability and validity of the translated IES-2-Chi. Subsequently, a survey was conducted using a general informational questionnaire, the IES-2-Chi, a diet history questionnaire, the Dutch Eating Behavior Questionnaire (DEBQ), a general self-efficacy scale, and the Stunkard Scale. Additionally, laboratory results and a physiological index of patients were collected and their current IE status and its influential factors in obese patients with hypertension were analyzed along with the questionnaires with the intention of proposing feasible prevention measures and strategies.

This study was approved by the ethics committee of the Affiliated Hospital of Hangzhou Normal University (IRB's registration number: 2019 Ethics 02-HS-46). This study complies with the international declaration of Helsinki, the ethical examination and Approval Measures for biomedical research involving human beings (Implementation), as well as the requirements of relevant laws and regulations. Informed consent was obtained from all subjects or, if subjects are under 18, from a parent and/or legal guardian.

2. Study 1

The primary aim of Study 1 was to examine the factor structure of the Chinese IES-2 (IES-2-Chi) as it corresponds with the structure of the original version published in English. It was hypothesized that the IES-2-Chi would maintain the four-factor structure of the original IES-2. The study also intended to examine the internal consistency and construct validity of the translated scale, with an expected acceptable internal consistency between the 23 items, as well as within each of the subscales, consistent with the original scale [11].

Materials and methodology

Participants and procedures

From January to December 2019, a convenience sampling method was used with examine obese patients with hypertension in the Department of Cardiology of a hospital in Hangzhou. A total of 205 obese patients with primary hypertension were selected, with an average age of 53.50 ± 14.95 years, BMI of 28.10 ± 3.78 kg/m^2, systolic blood pressure (SBP) of 143.51 ± 23.47 mmHg, and diastolic blood pressure (DBP) of 86.35 ± 15.83 mmHg. The majority of the sample was males 127 (62.0%) males, with 78 (38.0%) females; 102 (49.76%) subjects had completed ≤ primary school, 57 (27.8%) had completed junior high school or secondary vocational school, 30 (14.63%) subjects had completed senior high school or a three-year college, and 16 (7.81%) subjects had completed ≥ four-year university. The inclusion criteria are described below: patients meeting the diagnostic criteria of hypertension in the *Chinese Guidelines for Prevention and Treatment of Hypertension* (2016 revision), with a SBP ≥ 140 mmHg and/or a DBP ≥ 90 mmHg, who were diagnosed as hypertensive, or were taking hypotensive drugs; patients with a BMI ≥ 25 kg/m^2; patients who have signed the informed consent; patients with an age of ≥ 18 years; and patients with good compliance. The exclusion criteria were as follows: patients with serious medical complications; patients who were

pregnant or breast-feeding; patients with diagnosed mental disorders; patients with infectious diseases; patients with an excessive drinking problem (defined as daily drinking of spirits or beers of 150 g or ≥ 500ml); and patients with an unstable medical condition, on-going adjustment of hypotensive drugs, and BP fluctuations.

Translation process

The IES-2 is comprised of four subscales that are summed together to calculate a total score. The four subscales include 1) unconditional permission to eat (e.g., “If I crave a certain food, I am allowed to have it”, six items); 2) eating because of physiological as opposed to emotional reasons (e.g., “I use food to help me soothe my negative emotions”, eight items); 3) dependence on physiological hunger and satiety cues (e.g., “I rely on my hunger signals to tell me when to eat”, six items), and 4) body-food choice congruence (e.g., “I eat foods that give my body energy and stamina ”, three items). Each item is ranked on a 5-point Likert-type scale from 1 (strongly disagree) to 5 (strongly agree), with higher values indicating higher levels of intuitive eating. The addition of all items divided by 23 yields the total IES-2 scale score. IES-2 internal consistency reliabilities ranged from 0.87 to 0.89 for the total score and between 0.81 and 0.93 for each of the four subscales in a collegiate sample [11].

Localization and utilization rights for the IES-2 were obtained for the current study. The IES-2 was translated by two nursing experts proficient in English to create Chinese translations I and II. These two Chinese translations were then compared with the original scale by one medical expert to form Chinese translation III, and finally Chinese translation III was reviewed and revised by two new nursing experts to finally create the IES-2-Chi.

The IES-2-Chi was back-translated separately by one nursing expert proficient in English and one doctor of clinical medicine, for two back-translations. These two back-translations were then comparatively analyzed by the research group to find the sentences with varying semantics for re-translation to form the IES-2-Chi back-translation. Finally, the items with a difference between the IES-2-Chi back-translation and the IES-2 were revised after receiving comments from Professor Tylka to form the final version of the IES-2-Chi.

Cultural adaptation

Through the cultural adaption of sentences, while maintaining the primary meaning of the IES-2, the final version of the IES-2-Chi was reviewed by five experts in the fields of nursing, clinical medicine, and psychology to form the IES-2-Chi. All experts worked in their professional fields for ≥ 15 years and had a senior professional title. The content validity index (CVI) was calculated using a 4-point evaluation method (with 1-4 scores reflecting a range of “completely unrelated” to “highly related”).

A pilot test of the IES-2-chi was conducted on ten participants. The semi-structural interview of subjects was performed with 23 scale items and then these items were revised according to the comments of patients, so that the expressions were more concise and understandable. The subjects chose either “understand” or “do not understand” for the meaning of each item and then the “understand” rating of each item was analyzed. If the “understand” rating of all items was ≥ 90%, it suggested that the subjects could understand the meanings of all IES-2-Chi items. Finer adjustments to the wording were made to achieve a format that all translators agreed upon, with consideration to the English version. The final, agreed upon IES-2 version was used in the validity and reliability study.

Test-retest

Twenty randomly selected subjects completed the IES-2-Chi at baseline and one week later to examine the test-retest reliability using a Pearson correlation.

Measures

General Information Questionnaire

This questionnaire was self-made and included age, sex, professional status, and education.

Dutch Eating Behavior Questionnaire (DEBQ)

The DEBQ is a 33-item questionnaire that measures restrained, external, and emotional eating [17]. Restrained eating implies an intent to eat less in order to maintain or lose weight, external eating relates to choosing to eat after experiencing external food-related stimuli irrespective of physiological hunger cues, and emotional eating means one will want to eat following distinct emotions. Responses are rated on a 5-point Likert-type scale (1 = never; 5 = very often), with higher scores suggesting higher levels of restrained, external, or emotional eating. The current study demonstrated high internal consistency for all subscales; restrained eating (Cronbach's α = 0.91-0.92), external eating (Cronbach's α = 0.80-0.84), and emotional eating (Cronbach's α = 0.91-0.95), consistent with previous studies [12].

Body mass index (BMI)

BMI (kg/m^2) as measured by medical personnel was calculated using weight and height.

Data analysis

All data were analyzed using SPSS 23.0 and AMOS 21.0. Numerical data are presented using frequency and percentage (%), data with a normal distribution are presented with ±s, while data with a skewed distribution are presented with a median and interquartile range (IQR). The content validity of the scale was evaluated with an expert scoring method, including item-content validity (I-CVI) and scale-level content validity (S-CVI). The factor structure for the IES-2-chi was tested using an exploratory factor analysis, with the common factors extracted using a principal component analysis. Iinternal consistency was determined by using the Cronbach's α of the extracted factors and a Cronbach's α ≥ 0.7 was accepted as good reliability [21]. A confirmatory factor analysis was then used to assess the structural validity of the IES-2-Chi. Chi square degrees of freedom ratio (X^2/dF), RMSEA, RMR, GFI, CFI, TLI, IFI, and NNFI were all used to check the model fit of the four factor structure. Model fit standards are as follows: $\chi^2/df \leq 5$, RMSEA < 0.05, RMR < 0.08, GFI > 0.9, CFI > 0.9, TLI > 0.9, IFI > 0.9, NNFI > 0.9. The test-retest reliability of the scale was evaluated by the intra-group correlation coefficient (ICC) according to the model fit standards. Generally, ICC > 0.8 is considered good test-retest reliability.

A Pearson correlation coefficient was used for item analysis to study the relationship between IES, DEBQ, sex, and BMI. A $p < 0.05$ suggests that the difference was statistically significant.

Results

Analysis of items

All 205 subjects were sequenced according to the IES-2-Chi total score. The 27% of subjects with the highest IES-2-Chi total scores were included into the high score group, while the 27% of subjects with the lowest IES-2-Chi total scores were included in the low score group. The item scores in the two groups were compared using an independent sample t-test and results revealed a statistically significant difference in the scores of 23 items between the high and low score groups (ts = 5.239-17.982, all ps < 0.001). The correlation coefficients between various items and between item scores and the IES-2-Chi total score were 0.146-0.851 (ps < 0.05) and 0.483-0.863 (ps < 0.05), respectively. All items had good discrimination and representativeness and no items were deleted.

Analyses of validity

Content validity

In the current study, a total of five experts from relevant fields were requested to assess the content validity of the IES-2-Chi and to detect the degree to which the items reflected the measured contents using the item content validity index (I-CVI) and scale content validity index (S-CVI). The IES-2-Chi was evaluated for content validity using a four level Likert scoring method (1 = unrelated; 2 = weakly related; 3 = strongly related; 4 = highly related) and CVIs of the IES-2-Chi and its items were calculated. For each item, I-CVI was calculated by dividing how many experts provided scores of 3 or 4 by the total number of experts participating in the evaluation and then the S-CVI was calculated. The current study had I-CVI and S-CVI scores of IES-2-Chi at 0.80-1.00 and 0.861, respectively, and no item contents were modified.

Criterion-related validity

In the current study, the DEBQ was selected as external criterion and it had good reliability and validity. As demonstrated in the results, the coefficient of correlation between IES-2-Chi total score or dimension scores and the DEBQ total score was 0.430-0.867 (ps <0.01) and the IES-2-Chi had good criterion-related validity (see Table 1).

Table 1
Correlations between IES-2-Chi and DEBQ (n = 205, *r*)

Items	Unconditional permission to eat	Eating for physical rather emotional reasons	Reliance on hunger and satiety cues	Body-food choice congruence	IES-2-Chi total score	DEBQ total score
Unconditional permission to eat	1					
Eating because of physiological as opposed to emotional reasons	0.636**	1				
Dependence on physiological hunger and satiety cues	0.534**	0.465**	1			
Body-food choice congruence	0.690**	0.575**	0.493**	1		
IES-2-Chi total score	0.867**	0.862**	0.754**	0.778**	1	
DEBQ total score	-0.544**	-0.430**	-0.531**	-0.467**	-0.595**	1
**Represents $p < 0.01$.						

Construct validity

EFA

In the current study, EFA, Bartlett's test of sphericity, and KMO tests were performed on 205 patients, resulting in χ^2 = 3737.678 ($p < 0.001$) and a KMO value = 0.927 (> 0.8 acceptable), suggesting that these data were appropriate for factor analysis.

The common factors were extracted using a principal component analysis (PCA) and the factors with a characteristic value of ≥ 1.00 were retained. The results indicated that there were four extracted common factors, consistent results with the original scale. The explained variance of four dimensions was 46.856% (unconditional permission to eat), 10.720% (eating for physiological as opposed to emotional reasons), 8.092% (dependence on physiological hunger and satiety cues), and 4.707% (body-food choice congruence), with an accumulated explained variance of 70.375%. The factor loading results of the 23 items are shown in Table 2.

Table 2
EFA matrix of the IES-2-Chi (n = 205)

Items	Factor loading			
	Unconditional permission to eat	Eating for physical rather emotional reasons	Reliance on hunger and satiety cues	Body-food choice congruence
UPE				
1	0.715			
3	0.817			
4	0.789			
9	0.769			
16	0.775			
17	0.478			
EPR				
2		0.758		
5		0.779		
10		0.692		
11		0.778		
12		0.748		
13		0.702		
14		0.770		
15		0.623		
RHSC				
6			0.638	
7			0.738	
8			0.746	
21			0.803	
22			0.728	
23			0.836	
B-FCC				
18				0.726
19				0.746
20				0.763

CFA

In the current study, a confirmatory factor analysis (CFA) was conducted using a maximum likelihood estimation and the construct validity of IES-2-Chi was further validated by testing and model fitting. The following model fit indices were calculated: chi-square/degree of freedom ratio (χ2/df) = 1.318, RMSEA = 0.040, RMR = 0.053, GFI = 0.902, CFI = 0.982, TLI = 0.978, IFI = 0.983, and NFI = 0.932.

Analysis of reliability

Cronbach's and split-half reliability of IES-2-Chi were 0.947 and 0.850, respectively. Cronbach's and test-retest reliability of the various dimensions were 0.888-0.919 and 0.889, respectively. These findings suggest that IES-2-Chi had good reliability.

IES-2-Chi score

The analysis of the correlations between sex and BMI and the IES-2-Chi total score demonstrated a negative correlation between BMI and IE and no difference in IE between males and females ($p > 0.05$, see Table 3).

Table 3. Pearson correlation between BMI and IES-2-Chi (±*s*)

Variable	$\bar{x} \pm s$	*r*	*P*
BMI	28.10±3.78	-0.157	0.024

Discussion

Both EFA and CFA showed that a four factor model met the standards through various fit indices and had good basic adaption indicators, therefore complying with the principles of model access. These common factors were all related to the IES-2-Chi total score and had good discrimination and representativeness, similar to results in foreign college students, but different from those of Sajeevika [11,20]. Sajeevika found in pregnant women, the IES-2 total score and common factors represented drastically different eating behaviors. The reasons for these differences may be that the dietary tendencies of pregnant women are associated with gestational pressure and that these women had more freedom in their diet choices when approaching their third trimester of pregnancy, therefore exhibiting more of a tendency toward high-sugar or high-oil foods [22]. Therefore, the IES-2 may need to be adjusted and modified for clinical patients as subjects [20].

In the pre-survey, the understanding ratings of items 1 and 4 was < 60%. For item 1, most subjects asked which foods had high fats, high carbohydrates, and high calories. This may be related to the lower health literacy rate of Chinese citizens compared to the target in the *National Health Literacy Promotion Action Planning* (2014-2020) [23,24]. Sajeevika did not modify item 1, but the results from the current study demonstrated that the correlation coefficient of item 1 with the total score was significantly lower than the other items, suggesting that item 1 needed to be further modified during the introduction [20]. Similar to multiple foreign scholars, the term “regretful” was replaced by the term “angry” in item 4, which is more consistent with the psychological characteristics of subjects [20,25]. Additionally, there were some changes in the IES-2-Chi items which are similarly seen in other studies and have been approved by the original author.

The DEBQ and BMI were used in the current study, as in multiple other foreign studies, to test the criterion-related validity of the IES-2-Chi [26]. The current study results demonstrated that the IES-2-Chi total score was related with the DEBQ total score, as the IES-2-Chi and DEBQ had a similar measurement structure and theoretical foundation. Furthermore, consistent with Murat et al. [12,20], the current study demonstrated a negative correlation between BMI and IES-2 total score. Some scholars did not find a relationship between BMI and the IES-2 total score, possibly due to using a different population [12]. When revising the IES-2, Zoe et al. showed that the IES-2 total score was markedly lower in females, particularly young females, than in males [12,18]. Young females often strive for a more slender body usually by dieting, while males typically pursue a more muscular physique [27]. In the current study, there was no relationship demonstrated between sex and IE, but the IES-2-Chi total score in women was slightly greater than that in men, possibly because women were older, suffered from hypertension, and plausibly paid more attention to their health in ways other than having a slender body, which is typically focused on by young women. Barbara et al. observed that fewer elder women had anorexia and bulimia and also paid more concerns to diseases, menopause, and aging [28].

Cronbach's α of the IES-2-Chi and its various dimensions was 0.947 and ≥ 0.7, respectively. The test-retest reliability was 0.889, demonstrating that the scale had good measurement stability. This suggests that there are no major problems during localization and that each item can accurately represent the question asked. The KMO value of IES-2-Chi was 0.927 and the sample size met the requirements of the reliability and validity testing and the analysis of influential factors in the future.

3. Study 2

The second study aimed to identify intuitive eating (IE) of patients with primary hypertension and obesity in China and to examine factors related to IE to gather data in order to develop potential dietary intervention strategies.

Materials and methods

Participants and procedures

Participants were recruited from the department of cardiology who were hospitalized with primary hypertension and obesity. The questionnaires were disseminated from January to December 2020. The questionnaire was written in Chinese and was conducted by a researcher fluent in Mandarin as well as the local dialects.

It is generally believed that the number of observations is at least 5-10 times of that of the variables. Considering a 10% loss-of-follow-up rate with the 23 items in the IES-2-Chi, the sample size was determined to be 127-254. In the current study, a total of 235 questionnaires were disseminated, with 218 completed questionnaires returned, with an effective rate of 92.77%. Therefore, the sample size met the requirements.

Research ethics

The current study was approved by the Ethics Committee of the Affiliated Hospital of Hangzhou Normal University (IRB's registration number: 2019 Ethics 02-HS-46). Documents were provided to all subjects that contained an explanation of the purpose, the methods, and procedures of the study, the confidentiality of all data, and that subjects

could cease participation at any time for any reasons. Prior to participation, researchers obtained informed, written consent from all participants.

Variables measured and instruments used

Demographic data of age, sex, professional status, and education level were gathered given the assessments used in previous studies.

Laboratory and physiological levels including triglycerides, glycosylated hemoglobin, total cholesterol, low-density lipoproteins, high-density lipoproteins, red blood cells, hemoglobin, hematocrit, BMI, and blood pressure were collected using electronic medical records.

The DEBQ and IES-2-Chi were used to measure participants' eating behavior (for a detailed description of the scales, see study 1).

The General Self-Efficacy scale (GSE-6) short form was used to examine general self-efficacy, which is defined as the assurance in your skills when coping with various challenging tasks. All six items (e.g., "I can solve most problems if I invest the necessary effort") were rated from 1 (not true) to 4 (exactly true), with higher scores suggesting a higher level of self-efficacy. Internal consistency has ranged from □ = 0.79 to 0.88 and validity was established for negative relationships to the various constructs describing psychosocial stressors (e.g., depression or anxiety.) Cronbach's □ for the current study was 0.84 [29].

The diet history questionnaire is a self-designed form including four items: 1) "What are your favorite foods?"; 2) "How frequently do you eat fresh vegetables and fruits in a week?"; 3) "How frequently do you eat fast food?".

Body Image: The Stunkard Figure Rating Scale was used as an index to examine views of body image [30] by using nine male/female schematic silhouettes. The current study used three body size perception variables, namely current body size, ideal body size, and body size satisfaction. Current body size was evaluated by asking the participant to select a silhouette that best indicates his/her current body size, while ideal body size does the same but with the participant's ideal body size. Chronbach's α ranges from 0.79 to 0.89 [31]. The body size dissatisfaction was calculated by the discrepancy score between current body size and ideal body size.

Data analysis

Data was examined with SPSS Statistics 22.0 (IBM Corp., Armonk, MY, USA). Demographic characteristics, laboratory and physiological data, intuitive eating, self-efficacy, body image scores, and diet history using observed values, percentages, means, and standard deviations are all described. The differences in the participants' intuitive eating and diet history based on general characteristics were analyzed using independent t-tests. The relationships between intuitive eating, laboratory and physiological indicators, self-efficacy, and body image were assessed using Pearson's correlation coefficients. Additionally, influencing factors of participants' intuitive eating behaviors were assessed using multiple linear regression. The dependent variable was set as intuitive eating and the independent variables were set as self-efficacy, body image, and diet history.

Results

General characteristics

The participants ranged from 18 to 85 years old for the current study, with an average age of 54.41±15.19 years old. Most of the participants were male (62.4%) and employed (59.6%), while 13.3% were unemployed and 27.1% were retired. Additionally, most had not completed primary school (34.4%), while 30.3% completed junior high school, 27.1% had a high school education, and 8.3% had an undergraduate education or above.

Intuitive eating status

The mean IES-2-chi total score (max = 115) for patients with essential hypertension and obesity was 68.58±17.33 (mean ± SD). The mean score of each item (max = 5) was 2.98±0.75, while the mean scores of the four-subscale were 2.95±0.93, 3.03±0.92, 2.91±0.89, and 3.06±0.96 for unconditional permission to eat, eating because of physiological as opposed to emotional reasons, dependence on physiological hunger and satiety cues, and body-food choice congruence, respectively (see Table 4).

Table 4
IES-2-Chi scores of obese patients with hypertension ($\bar{x}$±s, n = 218)

Item	Number of items	Score
Unconditional permission to eat	6	2.95±0.93
Eating because of physiological as opposed to emotional reasons	8	3.03±0.92
Dependence on physiological hunger and satiety cues	6	2.91±0.89
Body-food choice congruence	3	3.06±0.96

Differences in IE based on demographic characteristics and diet history

There were significant differences in the IES-2 total score according to the frequency of eating vegetables and fruits (t = 18.55, $p < 0.001$), frequency of eating fast food (t = 18.46, p<0.001), and participants' education levels (t = 3.161, p = 0.026). Post-hoc comparisons revealed that participants who had finished high school had a greater IES-2 total score than those who had other educational levels, the more often participants ate vegetables and fruits, the higher the IES-2 total scores, and that participants who ate almost no fast food had higher IES-2 total scores than did those who ate it often (see Table 5).

Table 5
Intuitive eating according to demographic characteristics and diet history

Variables		n	$\bar{x}\pm s$	t/*F*	*P*
Sex	Male	136	2.98±0.78	-0.171	0.864
	Female	82	2.99±0.72		
Age	18~	41	2.88±0.44	0.750	0.523
	40~	80	3.05±0.82		
	60~	92	2.99±0.81		
	80~	5	2.65±0.52		
Professional status	employed	130	2.98 ±0.75	1.070	0.345
	unemployed	29	3.01± 0.83		
	retired	59	3.15 ±0.76		
Education	≤ Primary school	75	2.87±0.72	3.161	**0.026**
	junior high school	66	2.86±0.78		
	high school education	59	3.19±0.77		
	≥ undergraduate education and above	18	3.18±0.57		
Food type	Ethnic foods	97	2.83±0.71	1.952	0.103
	Chinese foods	111	3.12±0.79		
	Western-style foods	3	3.10±0.50		
	Japanese/Korean foods	1	2.70		
	Foods from other countries	6	2.97±0.26		
Frequency of eating vegetables and fruits	Every day	92	3.24±0.72	18.55	**<0.001**
	3-5 days/week	68	3.07±0.71		
	1-2 days/week	42	2.61±0.57		
	Nearly none	16	2.09±0.48		
Frequency of eating fast foods	3-5 days/week	23	2.51±0.73	18.46	**<0.001**
	1-2 days/week	75	2.72±0.68		
	Nearly none	120	3.24±0.71		

Relationships between intuitive eating, laboratory, and physiological scores

The correlations between intuitive eating, laboratory, and physiological scores are shown in Table 6. Intuitive eating revealed a significant negative correlation with BMI (r= -0.151, $p < 0.05$), diastolic blood pressure (r = -0.163, $p < 0.05$), total cholesterol (r = -0.157, $p < 0.05$), low-density lipoprotein (r = -0.163, $p < 0.05$), hemoglobin (r = -0.201, $p < 0.01$), and hematocrit (r = -0.166, $p < 0.05$).

Table 6
Correlations between intuitive eating, laboratory, and physiological indicators

Variables	BMI	SBP	DBP	TG	TC	HDL	LDL	HbA1c	RBC	Hb	HCT
r	-0.151	-0.121	-0.163	0.118	-0.157	-0.063	-0.163	-0.032	-0.097	-0.201	-0.166
P	**0.026**	0.074	**0.016**	0.082	**0.020**	0.357	**0.016**	0.636	0.155	**0.003**	**0.014**

Note: BMI, body mass index; DBP, diastolic blood pressure; SBP, systolic blood pressure; TG, triglyceride; HDL, high-density lipoprotein; TC, total cholesterol; LDL low-density lipoprotein; HbA1c, hemoglobin A1C; RBC, red blood cell; HCT, hematocrit; Hb, hemoglobin.

Relationships between intuitive eating, eating behaviors, self-efficacy, and body image

The correlations between the primary variables are displayed in Table 7. Intuitive eating demonstrated a significant negative correlation with restrained eating (r = -0.380, $p < 0.01$), emotional eating (r = -0.514, $p < 0.01$), external eating (r = -0.427, $p < 0.01$), eating behaviors (r = -0.380, $p < 0.01$), and body size perception (r = -0.587, $p < 0.01$), respectively. Additionally, intuitive eating demonstrated a significant positive correlation with self-efficacy (r = 0.151, $p < 0.05$).

Table 7
Correlations between intuitive eating, eating behavior, self-efficacy, and body image

Variables	Restrained eating	Emotional eating	External eating	Eating behaviors	Self-efficacy	Body image
r	-0.380	-0.514	-0.427	-0.587	0.151	-0.348
P	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.05**	**<0.01**

Factors influencing intuitive eating

The factors independently related with IE were determined using a multivariate regression. The multiple linear regression analysis was carried out with IE total score as the dependent variable ($\hat{Y}_1$) and the factors of statistical significance in one-way and correlation analyses as the independent variables. The dummy variables were set for categorical variables (the values of the independent variables are shown in Table 8, $\alpha_{inclusion} = 0.05$, $\alpha_{exclusion} = 0.10$). The results revealed a significant regression model (F = 22.886, $p < 0.001$), with an adjusted coefficient of

determination (adjusted R^2) of 0.526 for the power interpretation of the model. According to the comparison of absolute values among the standardized regression coefficients of variables, the contribution of independent variables to IE of patients was sequenced as: eating behaviors > body image > frequency of eating fast food > frequency of eating vegetables and fruits (see Table 9). These influential factors jointly explained 52.6% of the variance in IE.

Table 8
Evaluation of independent variables

Independent variables	Evaluation method
Education	The dummy variables were set with the baseline of "≤ Primary school". Dummy variable X_1 (≤ Primary school = 0, junior high school and secondary vocational school = 1, senior high school and three-year college = 0, ≥ Four-year university = 0) Dummy variable X_2 (≤ Primary school = 0, junior high school and secondary vocational school = 0, senior high school and three-year college = 1, ≥ Four-year university = 0) Dummy variable X_3 (≤ Primary school = 0, junior high school and secondary vocational school = 0, senior high school and three-year college = 0, ≥ Four-year university = 1)
Frequency of eating vegetables and fruits	The dummy variables were set with the baseline of "every day". Dummy variable X_4 (every day = 1, 3-5 days/week = 0, 1-2 days per week = 0, nearly none = 0) Dummy variable X_5 (every day = 0, 3-5 days/week = 1, 1-2 days per week = 0, nearly none = 0) Dummy variable X_6 (every day = 0, 3-5 days/week = 0, 1-2 days per week = 1, nearly none = 0)
Frequency of eating fast food	The dummy variables were set with the baseline of "nearly none". Dummy variable X_7 (every day = 1, 3-5 days/week = 0, 1-2 days per week = 0, nearly none = 0) Dummy variable X_8 (every day = 0, 3-5 days/week = 1, 1-2 days per week = 0, nearly none = 0) Dummy variable X_9 (every day = 0, 3-5 days/week = 0, 1-2 days per week = 1, nearly none =0)
Body image	Numerical variable
Eating behaviors	Numerical variable
Self-efficacy	Numerical variable

Table 9
Multivariate stepwise regression analysis of IE-related factors in obese patients with hypertension (n=218)

Variables	Regression coefficient	Standard error	Standardized regression coefficient	t	p
(Constant)	100.523	4.746	-	21.178	<0.001
Eating behaviors	-0.324	0.040	-0.420	-8.161	<0.001
Unsatisfied with body image	-3.715	0.725	-0.248	-5.127	<0.001
Frequency of eating vegetables (reference: “every day”)					
1-2 days per week	-5.590	2.404	-0.127	-2.325	0.021
Nearly none	-12.819	3.497	-0.193	-3.666	<0.001
Frequency of eating snack foods (reference: “nearly none”)					
3-5 days/week	-10.031	2.851	-0.178	-3.518	0.001
1-2 days/week	-7.982	1.925	-0.219	-4.146	<0.001

Note: Coefficient of determination: R^2 = 0.550, adjusted R^2 = 0.526, F = 22.886, $p < 0.001$.

Discussions and Recommendations

The results of the current study suggest that the mean score of IES-2-Chi items in the obese population with primary hypertension is lower than IE scores of community citizens in Australia (2.98±0.75 vs. 3.32±0.89) [32]. Combined with the correlation analyses of IE, restrained eating, external eating, and emotional eating, this difference may be attributed to multiple reasons. First, obese patients with primary hypertension often know the adverse effects of obesity on BP, blood lipids, and body image, and therefore may lose weight and lower BP and blood lipids by dieting. As time goes on, however, several of these patients experience weight gain and can have abnormal eating behaviors like over-drinking and over-eating [33], further decreasing their IE score. Secondly, due to a continuously increased weight or frequent dieting failure experiences, obese patients with primary hypertension may have negative emotions, which can sometimes cause excessive eating. This suggests that it is necessary to timely identify the negative emotions of patients in clinical practice and to subsequently provide a targeted psychological intervention. Finally, the neglect of physiological signals (hunger and satiety) is an important reason for overeating. When one’s eating speed is too fast, the brain’s central nervous system cannot recognize satiety cues and therefore fails to timely execute feedback inhibition. When the patient feels full, they have already eaten too much food. Furthermore, people typically eat a certain volume of food and the stomach will expand accordingly, resulting in a sense of satiety. Some subjects like foods with high energy density, such as sugary drinks, cakes, etc. These foods have high energy density but small volume. Subjects need to eat more of these foods to feel full, so they can easily intake excessive calories, thereby contributing to being overweight or obese [34].

In the current study, IE scores of obese patients with hypertension was negatively correlated with BMI, DBP, TC, LDL, Hb and HCT (all *ps* 0.05). The relationship between IE and BMI is consistent with most other studies [35]. The current research population is that of patients with primary hypertension and obesity. High DBP, TC, and LDL are common symptoms of this population and these symptoms are closely related to dietary habits. It should be considered that the intervention of intuitive eating may not only reduce the BMI of patients with primary hypertension and obesity, but may

also reduce blood pressure and lipid levels. However, some scholars demonstrated no associations between IE and BMI [12], which may be due to different sample compositions. The negative correlations of IE with Hb and HCT may be explained by the tendency of iron deficiency in an obese population, which can reduce Hb synthesis and therefore influence the shape of red blood cells, subsequently inducing chronic anemia. Chronic anemia typically shows symptoms of fatigue, weakness, and a decrease in the amount of exercise, which will further hinder the weight loss of patients [36]. This suggests the need for additional attention to nutritional elements while providing weight loss guidance for obese patients with primary hypertension and to avoid simplified weight reduction strategies to prevent the occurrence of anemia.

The current study also showed that IE was affected by eating behaviors, general self-efficacy, body image, and frequencies of eating vegetables, fruits, and fast foods in obese patients with primary hypertension. The subjects with greater general self-efficacy tended to show higher IES-2-Chi total scores. Self-efficacy refers to an overall confidence that people feel they are able to make good decisions in response to challenges in various environments or when encountering new things, i.e., individuals believe they can deal with life challenges. Good self-efficacy can improve the environmental control of individuals. The enticement from delicious foods is present everywhere. Food is required for human survival and the stimuli related to food can easily attract the attention of individuals, causing a decline in the ability to control behaviors using active attention. As a result, individuals may find it more difficult to focus on physiological hunger and satiety cues, which can instead result in excessive caloric intake. Therefore, subjects with greater self-efficacy may be better suited to resist external stimuli and therefore had a higher IE score. Additionally, higher IE scores were found in the subjects with a higher body image scores. Body image [32] refers to the degree to which individuals accept, respect, and appreciate their bodies. Due to an unsatisfying physical profile, obese patients with hypertension may pay excessive attention to a change in their body image and ignore the body's physiological hunger and satiety cues. Such thoughts and eating behaviors may perhaps eventually cause eating disorders such as over-drinking and over-eating. As shown by Tylka et al. [11], there was possibly dual-directional regulation between body image and IE; the patients with a high IE level had higher body image scores and their appreciation to their body image also could further promote their respect to body signals, thereby increasing IE level. This suggests the need to continue praising the body image of patients in a clinical setting and to provide positive guidance to improve their body image score. A higher IE score was also found in subjects with a greater frequency of eating fresh vegetables and fruits or a lower frequency of eating fast food, consistent with Saunders et al. [37]. Based on the concept of IE, subjects with a high IE level may be prone to choosing beneficial foods in response to physiological hunger. According to the results of Barad et al. [38], an IE survey involving college students demonstrated that the IES-2 total score had a positive correlation with vegetable intake in females, but no correlation in males. However, the vegetable intake was correlated negatively with UPE scores but had a significantly positive correlation with B-FCC scores. These differences may be attributed to different study populations and cultural backgrounds.

Conclusions

The current study demonstrated some novel and critical results. First, the IES-2-Chi is a scientific and effective scale that can be used to evaluate IE in a Chinese obese population with primary hypertension. Second, this is the first study to examine laboratory results with IE, demonstrating that IE can influence TC, LDL, Hb and HCT levels of this population. Third, the results of this study reveal that it is critical to identify the influencing factors to improve intuitive eating.

The current study has a few limitations that should be focused on in future studies. First, this study utilized a university affiliated hospital in Hangzhou, China. Furthermore, it used a single center, which contributes to sample limitations. In addition, this study is a cross-sectional study and the research results are therefore subject to the inherent limitations of

cross-sectional data. Future research can more deeply explore the influencing factors of intuitive eating through multi-center and/or longitudinal research.

Declarations

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File. Questionnaire (English).

Statement of authorship

All authors contributed satisfactorily to take responsibility for the content of this manuscript and have read and approved the final version.

Conflict of interest

Authors declare no conflicts of interest.

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