The Yale Food Addiction Scale 2.0 and the modified Yale Food Addiction Scale 2.0 in Taiwan: Factor structure and concurrent validity

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Introduction: The most widely used instruments to assess food addiction – the Yale Food Addiction Scale 2.0 (YFAS 2.0) and its modified version (mYFAS 2.0) – have not been validated in a Taiwanese population. The present study compared the psychometric properties between the Taiwan versions of YFAS 2.0 and mYFAS 2.0 among university students.

Methods: An online survey comprising the YFAS 2.0, mYFAS 2.0, Weight Self-Stigma Questionnaire (WSSQ) and International Physical Activity Questionnaire-Short Form (IPAQ-5F) were used to assess food addiction, self-stigma, and physical activity.

Results: All participants (n = 687; mean age = 24.00 years [SD ± 4.48 years]; 407 females [59.2%]) completed the entire survey at baseline and then completed the YFAS 2.0 and mYFAS 2.0 again three months later. The results of confirmatory factor analysis (CFA) indicated that the YFAS 2.0 and mYFAS 2.0 both shared a similar single-factor solution. In addition, both the YFAS 2.0 and mYFAS 2.0 reported good internal consistency (Cronbach’s $\alpha = 0.90$ and 0.89), good test-retest reliability (ICC = 0.71 and 0.69), and good concurrent validity with the total scores being strongly associated with the WSSQ ($r = 0.54$).
Introduction

Broadly speaking, the definition of food addiction refers to individuals’ uncontrollable desire for food intake (1). The concept of “Addiction and Related Disorders” proposed in the fifth edition of the Diagnostic and Statistical Manual for Mental Disorders (DSM-5) has allowed the potential diagnosis of varied behavioral addictions (2) and research investigating their potential associations has increased rapidly (1, 3). Food addiction has been shown to correlate with eating disorders such as binge eating and mood disorders such as impulsivity (1, 3, 4). In addition, food consumption is reported to alter the brain’s reward system (4), and individuals tend to increase their food intake as a compensatory behavior (typically to cope with negative situations in their lives), often resulting in weight gain (4). Consequently, these negative psychological and physiological impacts mean that food addiction is an issue that needs to be investigated.

Although food addiction is an important issue and worthy of further investigation, there have been debates in the literature in relation to the lack of appropriate instruments (5). However, since the development of the Yale Food Addiction Scale (YFAS), substantial empirical evidence showing the clinical relevance of food addiction has been documented (6–8). Therefore, food addiction is now a recognizable concept and there is growing interest among experts in the field of eating and weight disorders (5). The YFAS adapted the substance use criteria listed in the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) (9) to quantify the presence or absence of food addiction. Prior psychometric evidence has illustrated the soundness and robustness of the YFAS in assessing food addiction (6–8, 10). Moreover, a revised second version (i.e., YFAS version 2.0; YFAS 2.0) has been developed to correspond to the latest edition of DSM (i.e., DSM-5) (11). Therefore, the diagnostic ability of the YFAS and YFAS 2.0 is clinically relevant.

The YFAS 2.0 has also been validated across different language versions with satisfactory findings (11–17). In the YFAS 2.0, the food addiction criteria comprise 12 symptoms, with the first 11 being used to assess the presence or absence of food addiction based on the DSM-5 and a twelfth symptom relating to significant impairment as a result of eating (11). The 12 symptoms are (i) substance consumption (i.e., consuming more food than intended); (ii) persistent desire (i.e., being unable to cut down or stop consuming food); (iii) time expenditure (i.e., time spent consuming food); (iv) activity reduction (i.e., giving up important activities due to consuming food); (v) knowledge consequences (i.e., keeps consuming food despite knowing physical/emotional consequences); (vi) tolerance (i.e., increase of food consumption over time); (vii) withdrawal (i.e., having withdrawal symptoms if unable to eat desired foods); (viii) social problems (i.e., consuming food despite having social or interpersonal problems); (ix) failure to fulfill role (i.e., unable to satisfy role obligations due to consuming food); (x) hazardous situations (i.e., consuming food that causes physically hazardous situations); (xi) craving (i.e., having strong desire to consume desired food); and (xii) significant impairment (i.e., having significant distress or impairments due to food consumption) (11). However, the YFAS 2.0 contains 35 items, which in the present authors’ view may cause survey fatigue at a time when healthcare providers need to quickly obtain food addiction information in a busy clinical setting. Indeed, the developers of YFAS 2.0 shared a similar opinion that the 35-item YFAS 2.0 may cause survey burden for large-scale epidemiological research (18). Therefore, a shorter modified version of the YFAS 2.0 has been developed (i.e., mYFAS 2.0) (18).

The primary benefit of the mYFAS 2.0 is that it contains only 13 items with the same structure of the YFAS 2.0 (i.e., having 12 symptoms with 11 being diagnostic criteria corresponding to the criteria listed in the DSM-5 for substance use disorder) (18). The construct validity of the mYFAS 2.0 has been confirmed in prior research and has supported the 11-factor structure of the mYFAS 2.0 (18). Moreover, the association between the mYFAS 2.0 and its original version (i.e., YFAS 2.0) has been found to be satisfactory (18, 19). As far as the present
would have a first-order unidimensional structure using 11 symptom scores converted from YFAS 2.0 35 items; (ii) Taiwan version of YFAS 2.0 would have a second-order factor structure using YFAS 2.0 35 item scores; and (iii) mYFAS 2.0 would have a first-order unidimensional structure using 11 symptom scores converted from 13 mYFAS 2.0 items.

Materials and methods

Participants and process

The present study recruited university students who met the following inclusion criteria: (i) being a student registered in a university program; (ii) being able to understand traditional Chinese characters and read them in the online survey; and (iii) being aged 20 years or older. The present study did not recruit participants aged between 18 and 20 years because the current Civil Law in Taiwan defines an adult as being aged 20 years or above (28, 29). Therefore, participants aged between 18 and 20 years needed to have their parents’ consent to participate in the present study. However, because the present study used an online survey with the adoption of e-consent, it was difficult to identify if parents provided consent for their 18–20-year-old children to participate. The corresponding author passed on the survey information to university students and university faculty members to seek their help in disseminating the survey information (i.e., utilizing a snowballing sampling method). More specifically, the survey was distributed to five universities (comprising National Cheng Kung University located in Southern Taiwan, Kaohsiung Medical University located in Southern Taiwan, Asian University located in Central Taiwan, National Taipei University of Education located in Northern Taiwan, and National Taitung University located in Eastern Taiwan). The survey was completed using Google Forms and all the survey items were mandatory. Moreover, the expected sample size for the present study was 500, a sample size that could satisfy the requirement of confirmatory factor analysis (CFA) in calculating precise estimations (30).

All individuals were requested to provide informed consent by clicking an ‘agree’ icon after reading the survey information and confirming they would like to continue participating in the study. If an individual clicked the ‘disagree’ icon after reading the information, the window automatically shut down and no survey questions were accessible to them. Participants obtained a 100 New Taiwan Dollar coupon (about $3.3 US) after completing the survey and providing their contact information. The total sample size was 687 participants (407 females). Three months later, the authors sent a second survey for the participants again to complete. The present study protocol was approved by the Institutional Review Board in the Chi Mei Medical Center (IRB Serial No.: 11007-006) and the...
Human Research Ethics Committee in the National Cheng Kung University (Approval No.: NCKU HREC-E-109-551-2).

**Measures**

**Yale Food Addiction Scale 2.0 (YFAS 2.0) and modified YFAS 2.0 (mYFAS 2.0)**

The YFAS 2.0 contains 35 items rated using the following responses: never (score 0), less than monthly (score 1), once a month (score 2), 2–3 times a month (score 3), once a week (score 4), 2–3 times a week (score 5), 4–6 times a week (score 6), and every day (score 7). A sample item is "I ate to the point where I felt physically ill" (10, 11). The 35 items correspond to the 11 DSM-5 diagnostic criteria for substance use disorder (31) plus the symptom of impairment due to eating, and uses a similar structure to the first version of Yale Food Addiction Scale (i.e., YFAS 1.0) (9, 32). The diagnostic criteria are viewed as symptoms in food addiction (see Introduction for the specific criteria). A specific scoring method described by Gearhardt et al. (11) was used to convert the 35 items into the symptoms on a 0–1 dichotomous scale (0 indicates non-endorsed; 1 indicates endorsed).

The 13-item mYFAS 2.0 is a shorter version of the YFAS 2.0. However, the 12 symptoms remained in the mYFAS 2.0. Among the 13 items in the mYFAS 2.0, 11 items were used to assess the 11 DSM-5 diagnostic criteria and the remaining two items were used to assess significant impairment (i.e., having significant distress or impairments due to food consumption). The mYFAS 2.0 has also shown satisfactory psychometric properties (18, 24). The present study used Chinese versions of YFAS 2.0 and mYFAS 2.0 that were translated by a psychologist who is a native Chinese speaker with fluency in English.

**Weight Self-Stigma Questionnaire (WSSQ)**

The Weight Self-Stigma Questionnaire (WSSQ) contains 12 items rated on a five-point Likert scale (1 = strongly disagree; 5 = strongly agree) with a higher score indicating higher level of weight-related self-stigma. A sample item in the WSSQ is "I caused my weight problems" (33–35). The WSSQ used in the present study was a Chinese version which has reported promising psychometric properties in prior research (36). In the present study, the McDonald's \( \omega \) of the WSSQ was 0.95.

**International Physical Activity Questionnaire—Short Form (IPAQ-SF)**

The International Physical Activity Questionnaire—Short Form (IPAQ-SF) contains seven items assessing how an individual engages in physical activity during a one-week period. A sample item in the IPAQ-SF is "During the last 7 days, on how many days did you do vigorous physical activities?" Individuals are then asked to respond how many hours and minutes they engaged in such physical activity. Some examples were given for the individual to evaluate what activities belong to such physical activity (e.g., swimming). Following this, the metabolic equivalent of task (MET) is calculated according to answers on the IPAQ-SF. The IPAQ-SF defines that sitting equates to 1 MET; walking to 3.3 METs, moderate physical activity to 4 METs, and vigorous physical activity to 8 METs. According to these definitions, the METs an individual engages in during 1 week can be calculated. The IPAQ-SF used in the present study was a Chinese version which has reported promising psychometric properties in prior research (37, 38). In the present study, the McDonald's \( \omega \) of the IPAQ-SF was 0.70.

**Background information**

The background information sheet contains several items asking the participants' height (in cm), weight (in kg), sex (male or female), smoking status (current smoker or non-smoker), alcohol use (alcohol user or non-user), chronic disease condition (yes or no), and age (in years). For chronic diseases, an item asked "Do you have any chronic disease?". For those answered 'yes', a further question asked them to name the chronic disease(s). The participants' height and weight were further used to calculate body mass index (BMI) with the unit of kg/m².

**Data analysis**

In addition to the descriptive statistics, the present study used confirmatory factor analysis (CFA) to examine the factor structures of the YFAS 2.0 and mYFAS 2.0. The YFAS 2.0 was examined for two factor structures (a first-order structure and a second-order structure) according to the factor structures proposed by Manzoni et al. (39). For the first-order structure, each symptom derived from the YFAS 2.0 item calculation (please see "Measures" section for detailed scoring method) was treated as an observed score (using dichotomous scale; yes vs. no), and the first-order structure contains 11 observed item scores (Figure 1). The 12 symptoms were not included in the first-order structure because only the first 11 symptoms correspond to the DSM-5 diagnostic criteria (11). For the second-order structure, the 12 symptoms were all used as this can examine the entire YFAS 2.0. The second-order included the 12 symptoms and each symptom was constructed using 2–4 YFAS 2.0 items with a converted 0–1 scale score (please see "Measures" section for details). The two-factor structure is presented in Figure 2. Regarding the first-order structure for mYFAS 2.0, it is the same structure as the YFAS 2.0 first-order structure. However, the differences were mYFAS 2.0 only used one item score to indicate each symptom whereas the YFAS 2.0 used two to five item scores to indicate each symptom (also see "Measures" section for details).

All the CFA models were examined using maximum likelihood (ML) estimator with the asymptotic covariance
Confirmatory factor analysis (CFA) to examine the first-order structure of the YFAS 2.0 and mYFAS 2.0. Data are presented as factor loadings (aka standardized coefficients) for each YFAS 2.0 and mYFAS 2.0 symptom item, which were all stronger than 0.6.

Several fit indices were used to examine the fit between the data and model: comparative fit index (CFI) > 0.95; non-normed fit index (NNFI) > 0.95; and root mean square residual of approximation (RMSEA) < 0.08 were used to indicate satisfactory fit (22). However, if the original factor structure does not have good fit indices (in any of the fit indices), a modification index was used to improve the fit. The modification index was performed one at a time and stopped when the fit became satisfactory.

After confirming the factor structure of the YFAS 2.0 and mYFAS 2.0, other psychometric properties of the YFAS 2.0 and mYFAS 2.0 were examined. More specifically, the frequency distribution of the YFAS 2.0 and mYFAS 2.0 scores were calculated for the entire sample, and then compared between sexes; multigroup CFA was conducted to examine the measurement invariance of the YFAS 2.0 and mYFAS 2.0 across sex. In the multigroup CFA, three nested models were compared: configural model, model with factor loadings constrained as equal between sex groups, and model with factor loadings and item thresholds constrained as equal between sex groups. When CFI difference ($\Delta$CFI) > –0.01, the invariance is supported. Moreover, internal consistency was tested using McDonald’s $\omega$; test–retest reliability using intraclass correlation coefficient (ICC); and concurrent validity (with WSSQ, BMI, and IPAQ-SF) using Pearson correlation coefficients. Moreover, $\omega$ > 0.7 and ICC > 0.4 indicate good internal consistency and test–retest reliability, respectively (22). Pearson correlation > 0.1 indicates a small effect, >0.3 indicates a moderate effect, and >0.5 indicates a strong effect for concurrent validity (41). All the statistical analyses were performed using SPSS 25.0 (IBM Corp.: Armonk, NY, USA) or LISREL 8.8 (Scientific Software: Chicago, IL, USA).

**Results**

The mean age of the 687 participants was 24.0 ($SD = 4.48$) years. Moreover, there were more female participants in the

![Diagram of factor analysis](image-url)
FIGURE 2
Confirmatory factor analysis (CFA) to examine the second-order structure of the YFAS 2.0. Data are presented as factor loadings (aka standardized coefficients).

present sample ($n = 407; 59.2\%$). Most of the participants were studying in an undergraduate program ($n = 489; 71.2\%$), a non-smoker ($n = 663; 96.5\%$), a non-alcohol user ($n = 617; 89.8\%$), and had no chronic disease ($n = 649; 94.5\%$). The mean BMI of the participants was $22.52 \text{ kg/m}^2 (SD = 3.59)$ (Table 1). Moreover, the prevalence rate of food addiction in both the YFAS 2.0 and mYFAS 2.0 was $6.4\%$ ($n = 44$).

The original factor structures (both first-order and second-order) of the YFAS 2.0 were somewhat unsatisfactory in the RMSEA index ($0.113$ for first-order structure and $0.084$ for second-order structure). A similarly unsatisfactory RMSEA index was found in the first-order structure of mYFAS 2.0 ($0.107$). After correlating two pairs of measurement errors (activities reduced with failure fulfill role; and social problems with hazardous situations), all fit indices were satisfactory for the first-order structure (For YFAS 2.0: RMSEA = 0.059, CFI = 0.995, and NNFI = 0.993; for mYFAS 2.0: RMSEA = 0.054, CFI = 0.995, and NNFI = 0.994) (Table 2). Moreover, all factor loadings of each YFAS 2.0 symptom item and each mYFAS 2.0 symptom item were stronger than $0.6$ (Figure 1).

After correlating two pairs of residual errors (activities reduced with failure fulfill role; and social problems with hazardous situations), all fit indices were satisfactory for the second-order structure for YFAS 2.0 (RMSEA = 0.065, CFI = 0.972, and NNFI = 0.969). Table 3 additionally reports the coefficients, standard error (SE), and factor loadings of the final CFA results for both YFAS 2.0 and mYFAS 2.0.

Given that both the YFAS 2.0 and mYFAS 2.0 had satisfactory first-order structure, the total score using the 11 (DSM-5) symptom items was used for the following psychometric testing, including frequency distributions between males and females (Table 4), measurement invariance across sex (Table 5), internal consistency, test–retest reliability ($n = 445$)
participants for the test–retest), and concurrent validity. Significant differences were found between sexes in the YFAS 2.0 and mYFAS 2.0 scores. However, measurement invariance was supported for both YFAS 2.0 and mYFAS 2.0 across sex. Therefore, comparing sex using either YFAS 2.0 or mYFAS 2.0 is deemed appropriate. The impacts of sex on YFAS 2.0 or mYFAS 2.0 scores do not appear to be serious. For internal consistency, both YFAS 2.0 and mYFAS 2.0 had McDonald’s ω greater than 0.7 (0.96 for YFAS 2.0; 0.87 for mYFAS 2.0). For test–retest reliability, both YFAS 2.0 and mYFAS 2.0 had an ICC greater than 0.4 (0.71 for YFAS 2.0; 0.69 for mYFAS 2.0). For concurrent validity, both YFAS 2.0 and mYFAS 2.0 total scores had strong associations with WSSQ (r = 0.54 and 0.57) and small to moderate associations with BMI (r = 0.17 and 0.13) and IPAQ-SF (r = 0.23 and 0.25). Tables 6, 7 additionally report the details regarding the associations between each symptom of YFAS 2.0 (and that of mYFAS 2.0) and external criteria of WSSQ, BMI, and IPAQ-SF.

Discussion

The present study examined and compared the psychometric properties between the Taiwan versions of the YFAS 2.0 and the mYFAS 2.0 written in traditional Chinese characters among Taiwanese university students. The results concerning construct validity showed that both the YFAS 2.0 and the mYFAS 2.0 shared the same single-factor structural solution, which had a satisfactory fit with the construct of food addiction. In addition, the second-order construct of the Taiwan version YFAS 2.0 was further examined and the results demonstrated a well-fitting structure as supported by all fit indices. Other psychometric characteristics (including internal consistency, test–retest reliability and concurrent validity) were also satisfactory for both YFAS 2.0 and mYFAS 2.0, and suggest that the two instruments have relatively equivalent psychometric properties.

TABLE 2 Factor structure fit indices for the Yale Food Addiction Scale 2.0 (YFAS 2.0) and modified YFAS 2.0 (mYFAS 2.0).

| Instrument | Factor structure | Fit indices |
|------------|------------------|-------------|
| YFAS 2.0   | Modified first-order structure | χ² (df) | RMSEA (95% CI) | CFI | NNFI |
|            | 140.77 (42)      | 0.059 (0.048–0.069) | 0.995 | 0.993 |
|            | Modified second-order structure | 2127.938 (546) | 0.065 (0.062–0.068) | 0.972 | 0.969 |
| mYFAS 2.0  | First-order structure | 392.021 (44) | 0.107 (0.097–0.117) | 0.981 | 0.976 |
|            | Modified first-order structure | 125.250 (42) | 0.054 (0.043–0.065) | 0.995 | 0.994 |

CFL, comparative fit index; NNFI, non-normed fit index; RMSEA, root mean square error of approximation. a Adding the estimation of measurement errors: activities reduced with failure fulfill role; and social problems with hazardous situations. b Adding the estimation of residual errors: activities reduced with failure fulfill role; and social problems with hazardous situations.
### TABLE 3  Coefficients, standard error (SE), and standardized coefficients (aka factor loadings) of the final confirmatory factor analysis for the Yale Food Addiction Scale 2.0 (YFAS 2.0) and modified YFAS 2.0 (mYFAS 2.0).

| Symptom   | Coefficient (SE)/Standardized coefficient (All participants) | Coefficient (SE)/Standardized coefficient (Male) | Coefficient (SE)/Standardized coefficient (Female) |
|-----------|---------------------------------------------------------------|--------------------------------------------------|--------------------------------------------------|
| YFAS 2.0  | Modified first-order structure                                |                                                  |                                                  |
| Symptom 1 | 0.86 (0.03)/0.82                                              | 0.87 (0.05)/0.61                                 | 0.83 (0.05)/0.80                                 |
| Symptom 2 | 0.94 (0.02)/0.90                                              | 0.92 (0.04)/0.65                                 | 0.93 (0.02)/0.89                                 |
| Symptom 3 | 0.89 (0.03)/0.85                                              | 0.82 (0.08)/0.58                                 | 0.90 (0.04)/0.85                                 |
| Symptom 4 | 0.71 (0.04)/0.68                                              | 0.72 (0.05)/0.51                                 | 0.77 (0.04)/0.74                                 |
| Symptom 5 | 0.97 (0.01)/0.92                                              | 0.94 (0.03)/0.66                                 | 0.97 (0.01)/0.93                                 |
| Symptom 6 | 0.96 (0.02)/0.92                                              | 0.91 (0.04)/0.65                                 | 0.98 (0.02)/0.93                                 |
| Symptom 7 | 0.94 (0.02)/0.90                                              | 0.92 (0.03)/0.65                                 | 0.95 (0.02)/0.90                                 |
| Symptom 8 | 0.67 (0.04)/0.64                                              | 0.76 (0.05)/0.54                                 | 0.71 (0.05)/0.67                                 |
| Symptom 9 | 0.67 (0.04)/0.64                                              | 0.69 (0.06)/0.49                                 | 0.73 (0.04)/0.70                                 |
| Symptom 10| 0.78 (0.03)/0.75                                              | 0.83 (0.04)/0.59                                 | 0.79 (0.04)/0.75                                 |
| Symptom 11| 0.98 (0.01)/0.93                                              | 1.08 (0.02)/0.76                                 | 0.97 (0.02)/0.92                                 |
| YFAS 2.0  | Modified second-order structure                               |                                                  |                                                  |
| YFAS2_Item 1 | 1.00 (ref)/0.59                                          | 1.00 (ref)/0.58                                 | 1.00 (ref)/0.55                                 |
| YFAS2_Item 2 | 0.96 (0.08)/0.56                                          | 1.11 (0.15)/0.64                                 | 1.04 (0.13)/0.57                                 |
| YFAS2_Item 3 | 1.14 (0.09)/0.66                                          | 1.11 (0.15)/0.64                                 | 1.17 (0.15)/0.65                                 |
| YFAS2_Item 4 | 1.00 (ref)/0.55                                           | 1.00 (ref)/0.56                                 | 1.00 (ref)/0.56                                 |
| YFAS2_Item 5 | 1.17 (0.10)/0.65                                          | 1.20 (0.12)/0.68                                 | 1.14 (0.11)/0.64                                 |
| YFAS2_Item 6 | 1.24 (0.11)/0.69                                          | 1.22 (0.14)/0.68                                 | 1.23 (0.12)/0.69                                 |
| YFAS2_Item 7 | 1.30 (0.10)/0.72                                          | 1.30 (0.13)/0.73                                 | 1.28 (0.12)/0.72                                 |
| YFAS2_Item 8 | 1.00 (ref)/0.67                                           | 1.00 (ref)/0.67                                 | 1.00 (ref)/0.68                                 |
| YFAS2_Item 9 | 0.86 (0.08)/0.58                                          | 0.86 (0.10)/0.58                                 | 0.84 (0.09)/0.57                                 |
| YFAS2_Item 10 | 0.82 (0.07)/0.55                                          | 0.83 (0.10)/0.56                                 | 0.84 (0.08)/0.57                                 |
| YFAS2_Item 11 | 1.00 (ref)/0.68                                           | 1.00 (ref)/0.67                                 | 1.00 (ref)/0.68                                 |
| YFAS2_Item 12 | 0.91 (0.03)/0.62                                          | 0.96 (0.04)/0.64                                 | 0.94 (0.03)/0.64                                 |
| YFAS2_Item 13 | 1.04 (0.02)/0.70                                          | 1.06 (0.03)/0.71                                 | 1.02 (0.02)/0.69                                 |
| YFAS2_Item 14 | 1.01 (0.02)/0.69                                          | 1.04 (0.03)/0.69                                 | 1.02 (0.02)/0.69                                 |
| YFAS2_Item 15 | 1.00 (ref)/0.68                                           | 1.00 (ref)/0.68                                 | 1.00 (ref)/0.68                                 |
| YFAS2_Item 16 | 1.00 (0.03)/0.67                                          | 1.04 (0.03)/0.70                                 | 1.01 (0.02)/0.68                                 |
| YFAS2_Item 17 | 1.00 (ref)/0.69                                           | 1.00 (ref)/0.71                                 | 1.00 (ref)/0.70                                 |
| YFAS2_Item 18 | 1.01 (0.03)/0.70                                          | 0.99 (0.03)/0.70                                 | 1.01 (0.03)/0.70                                 |
| YFAS2_Item 19 | 1.00 (ref)/0.69                                           | 1.00 (ref)/0.68                                 | 1.00 (ref)/0.68                                 |
| YFAS2_Item 20 | 0.98 (0.02)/0.67                                          | 0.98 (0.04)/0.67                                 | 0.98 (0.03)/0.68                                 |
| YFAS2_Item 21 | 0.98 (0.02)/0.67                                          | 0.97 (0.03)/0.66                                 | 0.98 (0.02)/0.67                                 |
| YFAS2_Item 22 | 0.95 (0.03)/0.65                                          | 0.97 (0.03)/0.67                                 | 0.96 (0.03)/0.66                                 |
| YFAS2_Item 23 | 0.95 (0.04)/0.65                                          | 0.93 (0.06)/0.64                                 | 0.95 (0.04)/0.65                                 |
| YFAS2_Item 24 | 1.00 (ref)/0.65                                           | 1.00 (ref)/0.68                                 | 1.00 (ref)/0.68                                 |
| YFAS2_Item 25 | 1.10 (0.03)/0.72                                          | 1.06 (0.03)/0.71                                 | 1.06 (0.03)/0.72                                 |
| YFAS2_Item 26 | 1.05 (0.03)/0.68                                          | 1.02 (0.03)/0.69                                 | 0.99 (0.03)/0.67                                 |
| YFAS2_Item 27 | 1.00 (ref)/0.69                                           | 1.00 (ref)/0.68                                 | 1.00 (ref)/0.69                                 |
| YFAS2_Item 28 | 0.99 (0.02)/0.69                                          | 1.04 (0.02)/0.71                                 | 1.03 (0.02)/0.71                                 |
| YFAS2_Item 29 | 1.00 (ref)/0.65                                           | 1.00 (ref)/0.66                                 | 1.00 (ref)/0.67                                 |
| YFAS2_Item 30 | 0.96 (0.03)/0.62                                          | 0.97 (0.04)/0.64                                 | 0.95 (0.03)/0.63                                 |
| YFAS2_Item 31 | 1.02 (0.03)/0.66                                          | 1.03 (0.04)/0.68                                 | 1.02 (0.03)/0.68                                 |
| YFAS2_Item 32 | 1.00 (ref)/0.67                                           | 1.00 (ref)/0.68                                 | 1.00 (ref)/0.67                                 |
| YFAS2_Item 33 | 1.01 (0.03)/0.67                                          | 0.98 (0.04)/0.67                                 | 1.01 (0.03)/0.68                                 |
| YFAS2_Item 34 | 1.00 (ref)/0.67                                           | 1.00 (ref)/0.64                                 | 1.00 (ref)/0.67                                 |
| YFAS2_Item 35 | 1.05 (0.02)/0.70                                          | 1.13 (0.05)/0.72                                 | 1.07 (0.03)/0.72                                 |
TABLE 3 (Continued)

| Symptom | Coefficient (SE)/Standardized coefficient (All participants) | Coefficient (SE)/Standardized coefficient (Male) | Coefficient (SE)/Standardized coefficient (Female) |
|---------|-------------------------------------------------------------|--------------------------------------------------|--------------------------------------------------|
| mYFAS 2.0 | Modified first-order structure | | |
| Symptom 1 | 0.88 (0.03)/0.84 | 0.88 (0.05)/0.62 | 0.87 (0.05)/0.83 |
| Symptom 2 | 0.91 (0.03)/0.86 | 0.89 (0.05)/0.63 | 0.90 (0.04)/0.85 |
| Symptom 3 | 0.94 (0.03)/0.90 | 0.92 (0.06)/0.65 | 0.95 (0.03)/0.91 |
| Symptom 4 | 0.67 (0.05)/0.64 | 0.66 (0.07)/0.47 | 0.72 (0.05)/0.69 |
| Symptom 5 | 0.96 (0.02)/0.91 | 0.92 (0.03)/0.65 | 0.96 (0.02)/0.92 |
| Symptom 6 | 0.94 (0.03)/0.90 | 0.87 (0.06)/0.61 | 0.96 (0.03)/0.91 |
| Symptom 7 | 0.92 (0.02)/0.87 | 0.89 (0.05)/0.63 | 0.91 (0.03)/0.87 |
| Symptom 8 | 0.71 (0.04)/0.67 | 0.87 (0.04)/0.61 | 0.67 (0.06)/0.64 |
| Symptom 9 | 0.71 (0.04)/0.67 | 0.85 (0.05)/0.60 | 0.70 (0.05)/0.67 |
| Symptom 10 | 0.69 (0.04)/0.66 | 0.72 (0.07)/0.51 | 0.71 (0.05)/0.68 |
| Symptom 11 | 0.95 (0.02)/0.91 | 1.00 (0.03)/0.71 | 0.96 (0.02)/0.91 |

TABLE 4 Frequency distributions of the Yale Food Addiction Scale 2.0 (YFAS 2.0) and modified YFAS 2.0 (mYFAS 2.0) between male and female.

| Score | All participants (N = 687) | Male (N = 280) | Female (N = 407) | \( \chi^2 \) (p-value) |
|-------|-----------------------------|----------------|------------------|----------------------|
| YFAS 2.0 | | | | |
| 0 | 344 (50.1) | 126 (45.0) | 218 (53.6) | 23.41 (0.02) |
| 1 | 54 (7.9) | 24 (8.6) | 30 (7.4) | |
| 2 | 32 (4.7) | 20 (7.1) | 12 (2.9) | |
| 3 | 55 (8.0) | 31 (11.1) | 24 (5.9) | |
| 4 | 107 (15.6) | 44 (15.7) | 63 (15.5) | |
| 5 | 20 (2.9) | 10 (3.6) | 10 (2.5) | |
| 6 | 13 (1.9) | 2 (0.7) | 11 (2.7) | |
| 7 | 11 (1.6) | 6 (2.1) | 5 (1.2) | |
| 8 | 10 (1.4) | 5 (1.8) | 5 (1.2) | |
| 9 | 8 (1.1) | 1 (0.4) | 7 (1.7) | |
| 10 | 11 (1.6) | 4 (1.4) | 7 (1.7) | |
| 11 | 22 (3.2) | 7 (2.5) | 15 (3.7) | |
| mYFAS 2.0 | | | | |
| 0 | 373 (54.3) | 143 (51.1) | 230 (56.5) | 13.39 (0.26) |
| 1 | 69 (10.0) | 39 (13.9) | 30 (7.4) | |
| 2 | 42 (6.1) | 16 (5.7) | 26 (6.4) | |
| 3 | 30 (4.4) | 14 (5.0) | 16 (3.9) | |
| 4 | 91 (13.2) | 36 (12.9) | 55 (13.5) | |
| 5 | 22 (3.2) | 11 (3.9) | 11 (2.7) | |
| 6 | 10 (1.5) | 3 (1.1) | 7 (1.7) | |
| 7 | 11 (1.6) | 5 (1.8) | 6 (1.5) | |
| 8 | 10 (1.5) | 4 (1.4) | 6 (1.5) | |
| 9 | 10 (1.5) | 5 (1.8) | 5 (1.2) | |
| 10 | 5 (0.7) | 1 (0.4) | 4 (1.0) | |
| 11 | 14 (2.0) | 3 (1.1) | 11 (2.7) | |

3.3–8.2% (13, 15, 39, 44). These studies suggest that the YFAS 2.0 had a good feasibility for varied implementation.

The mYFAS 2.0 has been translated and validated in several languages, including English (i.e., the original version) (18), Italian (25), Brazilian (23), Czech (24), French (19), Chinese (21, 22), and Taiwanese (i.e., the present study). Two studies from the US (46) and Egypt (i.e., Arabic language) (47) have also reported partial psychometric characteristics for the mYFAS 2.0. Most of these studies have reported adequate to good construct validity of a single-factor structure, except for one study conducted in...
mainland China (21) which reported a two-factor structure. This may be due to transcultural adjustment (i.e., the cross-cultural item adjustment affects the scale’s original factor structure) and regional influences (e.g., the unique dietary habits in the area the study was carried out). Regarding the internal consistency, all previous studies have shown that the mYFAS 2.0 has a good α value (18, 19, 21–25, 47). Moreover, the concurrent validity verified through the correlations between food addiction and the selected measures have demonstrated good to excellent results in all previous studies. BMI has been the most frequently used measure to examine the concurrent validity of the mYFAS 2.0 (19, 21, 22, 47). Other measures such as impulsivity (21, 23) and binge eating (19, 22) have also been used in other studies as the validators and have found to be significantly associated with food addiction as assessed using the mYFAS 2.0. Despite the good aforementioned psychometric characteristics, to the best of the present authors’ knowledge (and like the YFAS), there have only been three studies (21, 22), including the present one, that have reported the test-retest reliability of the mYFAS 2.0. Furthermore, mYFAS 2.0 has also been implemented on different populations. One conducted in France (19) targeted a clinically obese population and reported a prevalence rate of 20.6%. Two of them targeted university students and reported prevalence rates of 6.2 and 6.7% (21, 22) which are very similar to the prevalence rate of 6.4% among university students in the present study. Other studies targeted on general population and reported prevalence rates of 4.3–17.6% (18, 19, 23–25, 46, 47). Like the YFAS 2.0, these studies suggest that the mYFAS 2.0 had a good feasibility for varied implementation irrespective of the types of group investigated.

Both the YFAS 2.0 and the mYFAS 2.0 are supported by a single-factor structure with 11 criteria and this structure can be explained by the 11 criteria described in the DSM-5. Substance-use disorder (SUD) comprises a pattern of symptoms derived from the continued use of a substance despite experiencing problems as a result (48). The concept of food addiction has been much debated particularly because food is essential for life maintenance rather than a psychoactive substance, therefore some claim it cannot be addictive (49).

However, the concept of food addiction has been reinforced by both animal studies (50, 51) and human studies (52, 53) which have shown the addictive-like responses and the withdrawal symptoms derived from food. This is why Gearhardt et al. (9) developed the first version of YFAS, and adopted the seven criteria of substance use listed in DSM-IV. With the publication of the DSM-5, the updated version of YFAS 2.0 (11) was developed according to the 11 revised diagnostic criteria. In the DSM-5, substance use was considered as a single disorder with different severity levels (31). The new diagnostic criteria combined the original criteria from DSM-IV with the four new concepts including “craving” resulting in 11 criteria (31), which basically refer to symptoms of “loss of behavioral control” that underpin addictive behavior (48). Therefore, the items in the YFAS 2.0 modeled the symptoms of addictive behavior to provide a solid construct of food addiction.

Research evidence has supported the association between weight-related self-stigma and BMI to food addiction (54). A theoretical model of cyclic obesity/weight-based stigma (COBWEBS) model (55) proposed that weight stigma generates the stress which evokes the eating disorder and increases food intake. The consequential weight gain and obesity worsen the stigmatization toward the individuals resulting in a vicious cycle. More specifically, stigmatized individuals internalize the perceived weight stigma to form the weight-related self-stigma (56). The resulting psychological distress (56) and vulnerability (57) may evoke an eating disorder which gradually develops into food addiction (54), causing an increased BMI and obesity. Moreover, the association between obesity and physical activity level is frequently reported (58). However, the mechanism remains unclear. The extant literature supports the hypothetical theory regarding the potential contribution of the dopamine motive system (59, 60). In the animal model, chronic exposure to obesogenic food impairs dopamine regulation (61). This further affects the control of effortful movement (59) and results in weight gain by reducing the physical activity level (60, 62).

### TABLE 5 Measurement invariance of the Yale Food Addiction Scale 2.0 (YFAS 2.0) and modified YFAS 2.0 (mYFAS 2.0) across sex.

|                      | Configural model | Loadings constrained as equal | Loadings and thresholds constrained as equal |
|----------------------|------------------|-------------------------------|--------------------------------------------|
| **YFAS 2.0 Modified first-order structure** | X²(df) or ΔX²(Δdf) | CFI or ΔCFI                  | CFI or ΔCFI                  |
|                      | 227.64 (84)      | 0.997                        | -0.009                                    |
| **YFAS 2.0 Modified second-order structure** | X²(df) or ΔX²(Δdf) | 232.19 (84)                 | 418.05 (10)                              |
|                      | 0.989            | 0.004                        | 0.005                                    |
| **mYFAS 2.0 Modified first-order structure** | X²(df) or ΔX²(Δdf) | 3055.61 (1092)              | 37.48 (35)                                |
|                      | 0.966            | 0.000                        | 27.72 (23)                                |

CFL, comparative fit index, and ΔCFI > -0.01 indicates measurement invariance.
### TABLE 6  Correlation between Yale Food Addiction Scale 2.0 (YFAS 2.0) and other variables \(N = 687\).

| Mean (SD)/\(n\ (%)\) | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  |
|------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| (1) YFAS 2.0 total score | 2.14 (2.91) | 1.00 |
| (2) Symptom/substance taken (Y) | 58 (8.44%) | 0.59 | 1.00 |
| (3) Symptom/persistent desire (Y) | 70 (10.19%) | 0.67 | 0.50 | 1.00 |
| (4) Symptom/much time spent (Y) | 46 (6.70%) | 0.59 | 0.55 | 0.58 | 1.00 |
| (5) Symptom/activities reduced (Y) | 251 (36.54%) | 0.79 | 0.26 | 0.26 | 0.26 | 1.00 |
| (6) Symptom/knowledge (Y) | 78 (11.35%) | 0.76 | 0.55 | 0.67 | 0.51 | 0.39 | 1.00 |
| (7) Symptom/tolerance (Y) | 52 (7.57%) | 0.69 | 0.57 | 0.70 | 0.56 | 0.30 | 0.68 | 1.00 |
| (8) Symptom/social problems (Y) | 102 (14.85%) | 0.72 | 0.49 | 0.63 | 0.53 | 0.36 | 0.69 | 0.59 | 1.00 |
| (9) Symptom/failure fulfill role (Y) | 264 (38.43%) | 0.77 | 0.23 | 0.26 | 0.23 | 0.84 | 0.37 | 0.29 | 0.34 | 1.00 |
| (10) Symptom/hazardous situation (Y) | 258 (37.56%) | 0.76 | 0.22 | 0.23 | 0.21 | 0.84 | 0.37 | 0.30 | 0.33 | 0.80 | 1.00 |
| (11) Symptom/craving (Y) | 222 (32.31%) | 0.79 | 0.26 | 0.35 | 0.26 | 0.74 | 0.46 | 0.34 | 0.45 | 0.73 | 0.71 | 1.00 |
| (12) Symptom/social problems (Y) | 69 (10.04%) | 0.75 | 0.56 | 0.69 | 0.57 | 0.38 | 0.71 | 0.67 | 0.68 | 0.32 | 0.36 | 0.43 | 1.00 |
| (13) WSSQ | 31.10 (10.49) | 0.54 | 0.21 | 0.27 | 0.22 | 0.49 | 0.38 | 0.29 | 0.35 | 0.50 | 0.47 | 0.53 | 0.31 | 1.00 |
| (14) BMI | 22.52 (5.97) | 0.17 | 0.12 | 0.07 | 0.09 | 0.17 | 0.09 | 0.09 | 0.10 | 0.20 | 0.18 | 0.10 | 0.04 | 0.31 | 1.00 |
| (15) IPAQ-SF | 3237.44 (2774.57) | 0.23 | 0.08 | 0.05 | 0.08 | 0.25 | 0.13 | 0.11 | 0.09 | 0.25 | 0.22 | 0.28 | 0.11 | 0.18 | 0.00 | 1.00 |

All correlations were significant except for those in bold, which did not meet \(p < 0.05\). WSSQ, Weight Self-Stigma Questionnaire; BMI, body mass index; IPAQ-SF, International Physical Activity Questionnaire-Short Form.
TABLE 7 Correlation between modified Yale Food Addiction Scale 2.0 (mYFAS 2.0) and other variables N = 687.

|                  | Mean (SD)/ n (%) | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  |
|------------------|------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| (1) mYFAS 2.0 total score | 1.79 (2.66)      | 1.00|     |     |     |     |     |     |     |     |     |     |     |     |     |
| (2) Symptom/substance taken (Y) | 43 (6.26%)      | 0.58| 1.00|     |     |     |     |     |     |     |     |     |     |     |     |
| (3) Symptom/persistent desire (Y) | 55 (8.01%)     | 0.61| 0.41| 1.00|     |     |     |     |     |     |     |     |     |     |     |
| (4) Symptom/much time spent (Y) | 32 (4.66%)      | 0.60| 0.63| 0.52| 1.00|     |     |     |     |     |     |     |     |     |     |
| (5) Symptom/activities reduced (Y) | 226 (32.89%)   | 0.75| 0.24| 0.23| 0.26| 1.00|     |     |     |     |     |     |     |     |     |
| (6) Symptom/knowledge (Y) | 74 (10.77%)     | 0.74| 0.55| 0.59| 0.53| 0.38| 1.00|     |     |     |     |     |     |     |     |
| (7) Symptom/tolerance (Y) | 40 (5.82%)      | 0.64| 0.50| 0.64| 0.54| 0.26| 0.60| 1.00|     |     |     |     |     |     |     |
| (8) Symptom/withdrawal (Y) | 75 (10.92%)     | 0.64| 0.49| 0.60| 0.59| 0.26| 0.60| 0.55| 1.00|     |     |     |     |     |     |
| (9) Symptom/social problems (Y) | 208 (30.28%)    | 0.80| 0.29| 0.27| 0.25| 0.72| 0.42| 0.28| 0.28| 1.00|     |     |     |     |     |
| (10) Symptom/failure fulfill role (Y) | 218 (31.73%)    | 0.79| 0.26| 0.23| 0.27| 0.73| 0.39| 0.30| 0.28| 0.79| 1.00|     |     |     |     |
| (11) Symptom/hazardous situation (Y) | 196 (28.53%)    | 0.80| 0.24| 0.24| 0.24| 0.73| 0.42| 0.30| 0.29| 0.83| 0.82| 1.00|     |     |     |
| (12) Symptom/craving (Y) | 61 (8.88%)      | 0.71| 0.53| 0.62| 0.56| 0.33| 0.67| 0.60| 0.56| 0.36| 0.36| 0.38| 1.00|     |     |
| (13) WSSQ | 31.10 (10.49)    | 0.57| 0.22| 0.28| 0.25| 0.48| 0.38| 0.27| 0.29| 0.58| 0.52| 0.55| 0.31| 1.00|     |
| (14) BMI | 22.52 (3.59)     | 0.13| 0.06| 0.08| 0.09| 0.15| 0.06| 0.05| 0.10| 0.14| 0.13| 0.08| 0.03| 0.31| 1.00|
| (15) IPAQ-SF | 3237.44 (2774.57) | 0.25| 0.07| 0.02| 0.10| 0.23| 0.10| 0.08| 0.06| 0.29| 0.29| 0.31| 0.11| 0.18| 0.00| 1.00|

All correlations were significant except for those in bold, which did not meet $p < 0.05$. WSSQ, Weight Self-Stigma Questionnaire; BMI, body mass index; IPAQ-SF, International Physical Activity Questionnaire-Short Form.
This theory may explain the alteration of physical activity level among individuals with food addiction and the reported association in the present study further supports this contention. There are some limitations in the present study. First, the sample population (i.e., university students) in the present study may mean the findings lack generalizability. More specifically, food addiction has been reported to have a higher prevalence among younger age populations (6, 18, 24). Therefore, the recruitment of university students as the present study’s population may have influenced the psychometric characteristics (e.g., construct validity or concurrent validity) in the present study. Second, the self-reported evaluation used in the present study may be subject to some study biases. For example, recall bias (e.g., the participants may have inaccurately recalled their food intake in the past 12 months), single rater bias (e.g., the participants may have had an error judgment due to their potential characteristics), and social desirability bias (e.g., the participants may have intentionally reported they had less food intake than they actually did). Third, the present study did not set questions to avoid bot respondents. However, the responses were closely checked and neither specific response pattern (e.g., answering all items in the same way) nor extreme height and weight (e.g., height over 200 cm) were found in the responses. Fourth, both Chinese version of YFAS 2.0 and mYFAS 2.0 used in the present study did not follow the international guidelines for translation. Instead, we obtained the scales from a psychologist who was approved to translate by the developers. Therefore, the linguistic validity is unknown. However, given that the present findings showed good psychometric results for both YFAS 2.0 and mYFAS 20, the present authors do not believe the linguistic validity to be a serious issue. Fifth, the psychiatric status of respondents was not evaluated because the survey was conducted online. Psychiatric conditions might have impacted the respondents’ ability to answer the online survey therefore it is unknown to what extent this may have biased the present study’s findings. Nevertheless, the present study provided the information regarding the psychometric properties of the Taiwan versions of the YFAS 2.0 and the mYFAS 2.0. Both instruments had a good fit with regard to construct validity and had similarity in concurrent validity. Therefore, it can be concluded that Taiwan versions of the YFAS 2.0 and the mYFAS 2.0 appear to be valid and reliable instruments for assessing food addiction.

Conclusion

Both the YFAS 2.0 and the mYFAS 2.0 appear to be robust instruments for assessing food addiction among Taiwanese young people. Their psychometric properties included a unidimensional structure corresponding to the DSM-5 criteria on SUD, a good test–retest reliability, and satisfactory concurrent validity. Based on the psychometric evidence, healthcare providers and food addiction researchers in Taiwan could use either the YFAS 2.0 or the mYFAS 2.0 to assess food addiction among the Taiwanese population (although further testing in non-university student populations is needed). Moreover, the mYFAS 2.0 has the advantage of being brief. Therefore, it may be more suitable than the YFAS 2.0 to be used in a busy clinical setting as a quick screening tool. In contrast, the YFAS 2.0 (as compared with the mYFAS 2.0) is perhaps more appropriate to use in the comprehensive assessment of food addiction, particularly in treatment settings.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by the Institutional Review Board in the Chi Mei Medical Center (IRB Serial No.: 11007-006) and the Human Research Ethics Committee in the National Cheng Kung University (Approval No. NCKU HREC-E-109-551-2). The patients/participants provided their written informed consent to participate in this study.

Author contributions

I-HC, P-CH, Y-CL, W-CY, and C-YL: substantial contributions to the conception or design of the work. I-HC, P-CH, WG, C-WF, W-CY, ST, WP, MDG, and C-YL: acquisition, analysis, or interpretation of data for the work. All authors drafting the work or revising it critically for important intellectual content, agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Conflict of interest

Author W-CY was employed by the company Infinite Power Ltd., Co.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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