Development and Preliminary Evaluation of Chinese School-aged Children’s Eating Behavior Scale

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Abstract

Background: The objective of this study was to develop a scale to assess eating behaviors of school-aged children (6-12 years old) in China.

Methods: To develop the scale, we reviewed the literature and conducted qualitative interviews. The draft scale contained 115 items and went through three evaluations among three groups of caregivers (n = 140, 400, 700) selected from suburban and urban kindergartens in Xi'an, Hanzhong, and Yanan, China, from March 2017 to October 2018. The psychometric properties of the score were assessed using exploratory, confirmatory factor analysis, and variability analysis.

Results: The final scale consisted of 46 items across 8 dimensions including food fussiness, satiety responsiveness, food responsiveness, bad eating habits, susceptible diet, restrained eating, enjoyment of food, and junk food addiction. The total cumulative variance contribution rate was 52.16%. The scale dimensions and Cronbach's α coefficients, Guttman split-half reliability, and test-retest reliability were all above 0.65. The fitting indices for the confirmatory factor analysis were all close to 1. The scores for education of caregiver, family structure, and the body mass index of children were different among dimensions and groups, thus suggesting good discriminative utility.

Conclusions: All the results indicated that the scale has good reliability and construct validity for evaluating the eating behaviors of school-aged children in China.

Background

The prevalence of overweight and obesity among children has been rapidly increasing globally in both developed and developing countries [1-3]. According to the standards of the Chinese Obesity Working Group (WGOC) in 2015, the prevalence of overweight and obesity in Chinese 7-year-old boys was 14.0% and 10.5%, respectively, and the corresponding prevalence in girls was 9.7% and 7.1% [4]. It is well known that overweight and obesity have substantial impacts on children's health. Overweight and obese children are more likely to maintain the same adiposity levels throughout adolescence and adulthood [5, 6], and the adverse psychological and physical consequences of being overweight and obese in childhood may also persist into adulthood [7]. Therefore, childhood obesity has become a serious public health problem that requires urgent attention [8].

Obesity is a multifaceted disorder that results from the interaction of numerous factors [9]. Observational studies have evaluated behavioral risk factors and found that eating behaviors, measured by psychometric tools and parental report, play vital roles in developing childhood obesity [10-12]. Several instruments have been developed to assess children's eating behaviors, such as the Children's Eating Behaviour Questionnaire (CEBQ) [13], the Dutch Eating Behaviour Questionnaire for Children (DEBQ-C) [14, 15], among others [16-18]. All of these instruments have different structures, merits and applicability, and they may not work well in other populations due to vast variations in culture, ethnicity, and dietary habits. For example, CEBQ was developed in the United Kingdom (UK) and was translated and adapted into the Chinese version [19]; however, the dimensions in the Chinese version were not entirely the same as the original questionnaire. As an example, the factor ‘food responsiveness’ was divided into two items, while ‘enjoyment of food’ and ‘satiety responsiveness’ were not found.

Recently, children's eating behaviors have received increased attention from both researchers and parents in China; however, most of the previous research includes epidemiological studies on the prevalence and factors of problematic eating behaviors [20-24]. In addition, most studies used self-developed non-validated questionnaires. Therefore, the assessment of eating behaviors may not be accurate and consistent across different studies. Substantial effort is needed to prevent overweight/obesity among children. Compared with other age groups, school-aged children (6 - 12 years) start to have increased self-consciousness, but poor self-control ability. Their learning ability and time spent in school also gradually increase, which provides an ideal opportunity to educate the children on healthy eating behaviors and prevent them from becoming overweight and obese. Due to the high overweight and obesity prevalence in China, it is important to have a valid and reliable instrument to be used by researchers and healthcare professionals to accurately measure the eating behaviors in Chinese school-aged children. However, to the best of our knowledge, no instrument has been validated and shown to be reliable for assessing school-aged children's eating behaviors in China.

In this study, we aimed to develop a scale (the Chinese School-aged Children's Eating Behavior Scale [CSCEBS]) to objectively assess eating behaviors of school-aged children in China. We also evaluated the psychometric property of this scale.

Methods

Participants

The present study was conducted in Xi'an, Hanzhong, and Yanan, China, between March 2017 and October 2018. To attain a representative population of school-aged children with difference in body weight, a random sampling technique was used to select schools located at different areas in these cities. The detailed study design is presented in Figure 1.
Caregiver was defined as someone who takes care of a child on a daily basis. The current study used the following criteria to include participants: 1) the child was between 6 and 12 years old, 2) the child did not suffer from any disease that might influence the child's appetite or eating behaviors in the past month, and 3) the caregiver of the child provided informed consent to take part in the survey. We excluded caregivers who were uneducated or not willing to participate.

The Ethics Committee of the Fourth Military Medical University approved the current study. Written informed consent was provided by all recruited caregivers prior to the study, and the study complied with related regulations and guidelines. Data was collected anonymously.

Information on the age, sex, height, and weight of a child, and the caregiver's levels of education, family structure, place of residence, and (family per capita) monthly income was collected using structured questionnaires. We also evaluated eating behaviors of children using the scale developed in the current study, namely the Chinese School-aged Children's Eating Behavior Scale (CSCEBS). Prior to data collection, we explained the aims, procedures, methods, each item's meaning, and the significance of the study, and we also gave instructions for filling out questionnaires.

**Development of the Conceptual Model and the Draft Scale**

We reviewed literature in English and Chinese published in the past 30 years, conducted two qualitative interviews, and developed a ten-factor conceptual model that systematically summarizes the eating behaviors of school-aged children (6 - 12 years old). During the first in-depth interview with 20 caregivers, we collected information on school-aged children's eating behaviors to the greatest extent possible using qualitative interviews. We then summarized the eating behaviors from the first interview and used the information in the second interview. The second interview was conducted with 30 caregivers and was structured as a focus group discussion examining the generalizability of items in the outline. Results from the second interview were used to build the conceptual model that included 10 dimensions: food fussiness, responsiveness to food, responsiveness to satiety, bad eating habits, external eating, emotional eating, independent and initiative eating, enjoyment of food, restrained eating, and junk food addiction.

Subsequently, 108 items were identified from the conceptual model and previous questionnaires (i.e., the DEBQ-C [14, 15], CEBQ [13], the Children Eating Behavior Inventory [16], the Oregon Research Institute Child Eating Behavior Inventory [17], Children's Binge Eating Disorder Scale [25], Mealtime Behavior Questionnaire [26]). In addition, a third interview was conducted among six caregivers and three nutrition experts to combine the characteristics of Chinese eating culture, and 60 additional items were identified capturing the ten-factor conceptual model. We used a forward-backward procedure to translate items from existing instruments. A nutritionist and two bilingual professional translators conducted the forward (English to Chinese) and backward (Chinese to English) translation. One psychologist and four nutrition experts further evaluated the content validity (relevance, clarity, and ambiguity of items) of the Chinese scale version. As a result, we formed an item pool of 168 items.

Fifty caregivers of school-aged children and 10 experienced pediatricians reviewed the item pool and critically evaluated each item, including the importance of each item (correlations with eating behaviors) and the frequency. Each item ranged from 1 (not very frequent or important) to 5 (very frequent or important). Therefore, 60 scores for frequency and 60 scores for importance were scored for each item. A higher mean score of an item indicates increased importance or frequency. We further deleted items that had low frequency or importance (< 50th percentile). After the review, 55 items were removed due to low frequency or importance. Ultimately, a draft of the Chinese School-aged Children's Eating Behavior Scale (CSCEBS) was created, which included 113 items.

**Methods for Scoring**

Each item of the scale measures the frequency of the corresponding eating behavior over the past two months. Five options were given for each item ("never", "rarely", "sometimes", "often", and "always"), and a corresponding number ranging from 1 to 5 was assigned respectively. Negative scores were given for reverse items. The mean score was calculated by dividing the total of all items by the number of items answered in each dimension. The score of the scale was the total of the scores in each dimension. A greater score for each dimension suggested a greater likelihood of children with this eating behavior.

**Investigation Methods**

The CSCEBS was administered to the main caregiver who had been feeding the child for more than 1 year and was very familiar with the child's daily diet. Five trained investigators were responsible for administering the questionnaire. The investigators first clarified the aim and process of the assessment, as well as the meaning of the questionnaire, to caregivers. Second, the height and weight of the child and the caregiver were measured using calibrated equipment (JT-918) by the investigators. Subsequently, caregivers completed the questionnaires to report their children's eating behaviors over the past 2 months, and returned the filled questionnaires to the investigators.

**First Investigation: Establishing the Trial Scale**

We reviewed literature in English and Chinese published in the past 30 years, conducted two qualitative interviews, and developed a ten-factor conceptual model that systematically summarizes the eating behaviors of school-aged children (6 - 12 years old). During the first in-depth interview with 20 caregivers, we collected information on school-aged children's eating behaviors to the greatest extent possible using qualitative interviews. We then summarized the eating behaviors from the first interview and used the information in the second interview. The second interview was conducted with 30 caregivers and was structured as a focus group discussion examining the generalizability of items in the outline. Results from the second interview were used to build the conceptual model that included 10 dimensions: food fussiness, responsiveness to food, responsiveness to satiety, bad eating habits, external eating, emotional eating, independent and initiative eating, enjoyment of food, restrained eating, and junk food addiction.

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**First Investigation: Establishing the Trial Scale**
The first investigation included 140 caregivers from two kindergartens in urban and suburban Xi'an using the stratified sampling methods. The first draft of the CSCEBS was completed by the caregivers independently, and was used for analyzing items of the draft scale.

**Second Investigation: Constructing the Final Scale**

The second investigation included 400 caregivers and utilized the same method and criteria from one urban and one suburban kindergarten in Xi'an, Hanzhong, and Yanan, respectively. The caregivers finished the trial scale of the CSCEBS independently for constructing the final CSCEBS.

**Third Investigation: Assessing the Final Scale**

The third investigation included 700 caregivers from two suburban and three urban kindergartens in Xi'an, Hanzhong, and Yanan. The caregivers completed the final scale independently, and the dimensions of the scale and the reliability and validity were assessed. To test the test-retest reliability, 120 caregivers were randomly selected to complete the scale again after two weeks.

**Methods for Quality Control**

The investigators carefully checked all questionnaires and conducted telephone interviews when spotting any missing information. Valid data from all completed questions were entered by using EpiData software. Double-entry and random check were used to ensure the data accuracy. SPSS was used to perform data analysis.

**Body Mass Index (BMI) Classification**

BMI (kg/m²) was calculated by measuring weight and height, and was classified separately for children and caregivers. For children, overweight and obesity were defined using the Chinese guideline for children aged younger than 18 years of age [27]. Three groups were created: thinner weight (age- and sex-specified BMI < 10th percentile), normal weight (BMI ≥ 10th percentile to < 85th percentile), overweight/obesity (BMI ≥ 85th percentile).

**Data Analysis**

**Item Analysis**

First, items that received the highest or lowest scores from over 15% of the caregivers indicated ceiling or floor effects, respectively [28], and were thus discarded. Second, we converted the reverse scoring items accordingly (5 = 1, 2 = 4, 4 = 2, and 1 = 5). Subsequently, we used five methods to select items [29]: the critical ratio analysis method, the discrete trend method, the correlation coefficient method [30], the exploratory factor analysis method [31], and the Cronbach's α coefficient method [32]. The details of the five methods have been described previously [29]. Based on these methods, an item was deleted when it met exclusion criteria of three or more methods; if an item met the exclusion criteria of two methods, it was discussed with experts to decide whether it should be deleted or merged.

**Reliability Analysis**

The Cronbach's α coefficient, test-retest reliability coefficient, and split-half reliability coefficient were used for reliability testing. If coefficients were ≥ 0.70 and 0.60 [32] for total scale and dimensions, respectively, then the reliability was considered satisfactory.

**Validity Analysis**

We split the samples into half and used exploratory factor analysis and confirmatory factor analysis to explore and validate the structure [33]. A few fit indices were used to assess how well the model fit the data [31, 34]. The details have been described previously [31, 33-35]. In brief, the standardized root mean squared residual (SRMR) > 0.08, the adjusted goodness-of-fit index (AGFI) and the goodness-of-fit index (GFI) > 0.90, the comparative fit index (CFI) and the non-normed fit index (NNFI) > 0.95, the χ²/df < 5, and the root mean square error of approximation (RMSEA) < 0.05 indicated good model fit [31].

**Discrimination Analysis**

We used the Student's t-test to compare scores of various dimensions between sex and place of residence. We used one-way analysis of variance to compare scores by age, weight, education level of caregiver, monthly income, and family structure. We used SPSS to perform all statistical analyses. Continuous variables are presented as the mean ± standard deviation (), and categorical variables are expressed as frequencies and percentages. Two-sided P values < 0.05 indicate statistical significance.

**Results**
Participants' Characteristics

Characteristics of participants are presented in Table 1. A total of 140 caregivers were recruited for the first investigation (sample 1), and 115 (82.1%) questionnaires were valid. For the second investigation (sample 2), 400 caregivers were enrolled and 363 (90.8%) completed questionnaires. A total of 700 caregivers were recruited for the third investigation (sample 3) and 684 (97.7%) questionnaires were valid.

Table 1. Demographic information of Chinese school-aged children and their caregivers participating in the Chinese School-aged Children’s Eating Behavior Scale

| Group          | Sample 1 (n=115) |          | Sample 2 (n=363) |          | Sample 3 (n=684) |          |
|----------------|-------------------|----------|-------------------|----------|-------------------|----------|
|                | n     | %      | n     | %      | n     | %      |
| er             | Boy    | 62 | 53.9 | 202 | 55.6 | 354 | 51.8 |
|                | Girl   | 53 | 46.1 | 161 | 44.4 | 330 | 48.2 |
| years          | 6-7    | 26 | 22.6 | 110 | 30.4 | 151 | 22.1 |
|                | 8-10   | 51 | 44.4 | 130 | 35.8 | 298 | 43.6 |
|                | 11-12  | 38 | 33.0 | 123 | 33.8 | 235 | 34.3 |
| Xi’an          |        | 115| 100.0| 363 | 100.0| 281 | 41.1 |
| Hanzhong       |        | -  | -    | -   | -    | 257 | 37.6 |
| Yanan          |        | -  | -    | -   | -    | 146 | 21.3 |
| kg/m²          | Thinner<sup>a</sup> | 9  | 7.8  | 35  | 9.7  | 60  | 8.8  |
|                | Normal<sup>b</sup> | 95 | 82.6 | 284 | 78.2 | 531 | 77.6 |
|                | Overweight/ obesity<sup>c</sup> | 11 | 9.6  | 44  | 12.1 | 93  | 13.6 |
| y structure    | Nuclear family<sup>d</sup> | 79 | 68.7 | 239 | 65.8 | 467 | 68.3 |
|                | Stem family<sup>e</sup> | 34 | 29.6 | 113 | 31.1 | 201 | 29.4 |
|                | Single parent family | 2  | 1.7  | 11  | 3.1  | 16  | 2.3  |
| of residence   | Urban    | 83 | 72.2 | 201 | 55.4 | 370 | 54.1 |
|                | Rural    | 32 | 27.8 | 162 | 44.6 | 314 | 45.9 |
| Station of caregiver | Junior high school or less | 20 | 17.4 | 70  | 19.3 | 120 | 17.5 |
|                | Senior high school | 42 | 36.5 | 119 | 32.8 | 249 | 36.4 |
|                | College or university or graduate | 53 | 46.1 | 174 | 47.9 | 315 | 46.1 |
| Monthly income (RMB,Yuan) | <3000 | 19 | 16.5 | 35  | 9.6  | 110 | 16.1 |
|                | 3000~   | 56 | 48.7 | 111 | 30.6 | 330 | 48.2 |
|                | ≥5000   | 40 | 34.8 | 217 | 60.6 | 244 | 36.7 |

<sup>a</sup>Age- and sex-specified BMI < 10th percentile.
<sup>b</sup>Age- and sex-specified BMI ≥ 10th percentile to <85th percentile.
<sup>c</sup>Age- and sex-specified BMI ≥ 85th percentile.
<sup>d</sup>Father, mother, and child.
<sup>e</sup>Father, mother, grandparent, and child.

Item Selection
From the first investigation, 31 items were deleted and 82 items were used to create a trial scale. We used the data of the second investigation to analyze and select items for the final scale. As a result, 36 items were deleted and a final scale was developed containing eight dimensions and 46 items. The detailed description for each item and the corresponding factor loading are shown in Table 2.

**Table 2.** Factor loading of the final Chinese School-aged Children’s Eating Behavior Scale (46 items) \((n = 342)\) \(^a\)
| Dimension name and item | loading | Dimension name and item | loading |
|-------------------------|---------|-------------------------|---------|
| **Junk food preference, JP (19.49)** |         | **Bad eating habit, BH (10.10)** |         |
| 1. My child likes to eat fried food, such as chips and fried chicken | 0.71    | 11. During a meal, my child will eat more and more slowly. | 0.52    |
| 2. My child likes to eat all kinds of puffed foods | 0.68    | 12. My child can sit before the dining-table obediently and finish his/her meal quickly | 0.52    |
| 3. My child prefers eating instant noodles, hamburger, pizza and other fast foods over family meals | 0.64    | 13. It takes more than 30 minutes for my child to eat his/her meal | 0.50    |
| 4. Between milk, yogurt and beverage, my child would choose beverage. | 0.64    | 14. My child has leftovers at every meal. | 0.47    |
| 5. My child especially likes to eat sweet foods, such as ice cream and candy. | 0.63    | 15. My child often needs to be fed during a meal. | 0.46    |
| 6. My child prefers to eat processed meat products, such as canned meat and sausage. | 0.62    | 16. My child only eats the food he/she selected. | 0.71    |
| 7. My children like to eat food with heavy flavors, such as salty and spicy ones. | 0.50    | 17. My child eats a limited variety of foods. | 0.67    |
| 8. During a meal, my child always plays while eating. | 0.65    | 18. My child doesn’t eat foods he/she hasn’t eaten before. | 0.63    |
| 9. Even if eats at home, my child doesn’t want to serve foods for himself/herself. | 0.61    | 19. If I do not allow to play with toys, watch TV or do other things, my child would not have his/her meal | 0.54    |
| 10. If I do not allow to play with toys, watch TV or do other things, my child would not have his/her meal |         | 20. My child likes to eat meat, but he will limit the amount he eats at a time. | 0.74    |
| 11. During a meal, my child will eat more and more slowly. | 0.52    | 21. My child is interested in food. | 0.46    |
| 12. My child can sit before the dining-table obediently and finish his/her meal quickly | 0.52    | 22. My child would eat more when eating in a restaurant or other family. | 0.51    |
| 13. It takes more than 30 minutes for my child to eat his/her meal | 0.50    | 23. Even if the same food ingredients are made into different patterns or style, my children will eat more. | 0.51    |
| 14. My child has leftovers at every meal. | 0.47    | 24. My child would eat more when eating in a restaurant or other family. | 0.51    |
| 15. My child often needs to be fed during a meal. | 0.46    | 25. Even if the same food ingredients are made into different patterns or style, my children will eat more. | 0.51    |
| 16. My child only eats the food he/she selected. | 0.71    | 26. My children eat more when there are guests at home. | 0.50    |
| 17. My child eats a limited variety of foods. | 0.67    | 27. My child eats more and faster when happy. | 0.47    |
| 18. My child doesn’t eat foods he/she hasn’t eaten before. | 0.63    | 28. My child chooses to eat when he/she feels lonely. | 0.46    |
| 19. If I do not allow to play with toys, watch TV or do other things, my child would not have his/her meal |         | 29. When someone plays with he/her, my child eats more. | 0.43    |
| 20. My child likes to eat meat, but he will limit the amount he eats at a time. | 0.74    | 30. During the meal, my child often say that if he/she eats too much, he/she will get fat | 0.74    |
| 21. My child is interested in food. | 0.46    | 31. My child likes to eat meat, but he will limit the amount he eats at a time. | 0.74    |
| 22. My child would eat more when eating in a restaurant or other family. | 0.51    | 32. My child often limits the amount of food he/she can eat for fear of gaining weight. | 0.70    |
| 23. Even if the same food ingredients are made into different patterns or style, my children will eat more. | 0.51    | 33. My child will limit himself/herself to drinks and snacks. | 0.65    |
| 24. My child would eat more when eating in a restaurant or other family. | 0.51    | 34. Whenever I give food, my child becomes happy | 0.65    |
| 25. Even if the same food ingredients are made into different patterns or style, my children will eat more. | 0.51    | 35. My child would be happy when meal time comes | 0.61    |
| 26. My children eat more when there are guests at home. | 0.50    | 36. My child is always asking for food | 0.57    |
| 27. My child eats more and faster when happy. | 0.47    | 37. If allowed, my child will keep eating. | 0.56    |
| 28. My child chooses to eat when he/she feels lonely. | 0.46    | 38. My child is interested in food. | 0.46    |
| 29. When someone plays with he/her, my child eats more. | 0.43    | 39. My child is always attracted to the food in the food shop. | 0.65    |
| 30. During the meal, my child often say that if he/she eats too much, he/she will get fat | 0.74    | 40. My child wants to eat when watching others eat | 0.64    |
| 31. My child likes to eat meat, but he will limit the amount he eats at a time. | 0.74    | 41. My child wants to eat when smelling or seeing foods | 0.60    |
19. My child refuses many food because of the food’s taste, smell, appearance, texture, etc. 0.59
20. If there is a little food in the meals that he/she does not like, he/she would not eat. 0.56
21. My child eats any kinds of foods\(^b\). 0.48

### Appetite, \( \text{AP (2.42)} \)

22. My child would eat more when using his/her favorite dishware. 0.58
23. My child eats more when there is nothing else to do. 0.52
24. My child eats less than other age-matched children. 0.48
25. My child gets full up easily. 0.46
26. My child has a good appetite\(^b\). 0.42

\( ^a \)This is half of Sample 3 sample size.
\( ^b \)Items with reverse score.

### Structure of the Questionnaire

The exploratory factor analysis was performed on half of the completed questionnaires randomly selected from the third investigation. The Kaiser-Meyer-Olkin of the sampling adequacy was 0.91 (> 0.6), and the Approx \( \chi^2 \) of Bartlett's test of sphericity was 15,274 (\( P < 0.05 \)). All results showed the fitness of data necessary for the exploratory factor analysis. The parallel analysis plot indicated that 8 factors should be extracted (Figure 2). The results of the exploratory factor analysis demonstrated that the Eigenvalues for these 8 factors were 10.18, 5.55, 3.28, 2.42, 2.06, 1.78, 1.53, and 1.33, and the variance contribution rates were 19.49%, 10.10%, 5.97%, 4.41%, 3.74%, 3.23%, 2.80%, and 2.42%. The cumulative rate of variance contribution was 52.16%. The factor loadings of all items were above 0.4 (Table 2).

To define the possible implication of each factor, we summed up the implicit meaning of the item with the higher loading in each factor (Table 2). Factor one contained seven items and was named “junk food addiction (JA)”; it reflects a child's preference for unhealthy food and drinks. Factor two included eight items named “bad eating habits (BH)”; it reflects a child's self-eating ability and unscientific, irregular, and unhealthy eating habits and behaviors. Factor three contained six items and was called “food fussiness (FF)”; it reflects a child's desire to usually eat only a few foods of his/her choice and reject other foods. Factor four contained eight items and was named “susceptible diet (SD)”; it reflects that a child's eating speed and food intake amount are easily affected by external factors and their own emotions. Factor five contained four items and was called “restrained eating (RE)”; it reflects that a child deliberately controls the choice and amount of the food intake because he/she is worried about being overweight or obese. Factor six contained five items and was called “enjoyment of food (EF)”; it reflects a child's enjoyment extent of all kinds of food. Factor seven contained five items and was named “food responsiveness (FR)”; it mainly reflects a child's desire to eat after he/she sees, smells, or is served food. Factor eight included three items named “appetite (AP)”; it mainly reflects the amount of food and appetite of a child compared with children of the same age.

### Reliability

All 684 subjects from the third investigation were used to analyze the internal reliability of the scale. The Cronbach’s \( \alpha \) coefficient was 0.89 for the total scale, and it ranged between 0.74 and 0.85 for the 8 dimensions. The Guttman split-half reliability coefficient of the scale was 0.71, and it ranged between 0.65 and 0.81 for the 8 dimensions. The two-week test-retest reliability coefficient of the scale was 0.73, and it ranged between 0.68 and 0.83 for the 8 dimensions (Table 3). In sum, the results showed that the scale has good reliability.

**Table 3.** Reliability coefficients of the final Chinese School-aged Children’s Eating Behavior Scale in all dimensions (n = 684)
The content validity ratio of the scale was 0.62. The mean time for finishing a survey was 23.0 ± 1.6 minutes, and participants said that they could easily understand the items of the scale. The correlation coefficient between scores of all dimensions ranged from 0.08 to 0.48; in comparison, the correlation coefficient between each dimension score and the total score was higher and ranged between 0.51 and 0.72. We further used the confirmatory factor analysis to evaluate the scale’s structure. Results of the statistics of the fit are shown as follows: $SRMR = 0.05 (< 0.08)$, $\chi^2 / df = 1.92 (< 5)$, $GFI = 0.90$, $AGFI = 0.89$, $NNFI = 0.92$, and $CFI = 0.93$. Each index value was close to 1, and $RMSEA = 0.04 (< 0.08)$. All of these indices met the statistical requirements [31, 35], indicating that the 8 dimensions of the scale provided good fit for the data. Principal component analysis was conducted for each dimension of the scale, and only one factor had an Eigenvalue greater than 1 in each dimension. The variance contribution rate was between 45% and 71%, and the factor loading of each item in each dimension was greater than 0.4. Thus, the indices suggested an adequate structural validity of the scale.

### Discriminant Ability

Table 4 shows that children in different age groups had significant differences in food fussiness, appetite, bad eating habits, susceptible eating, and restrained eating dimensions ($P < 0.05$). When age increased, the score of the dimensions of appetite and restrained eating also increased, and the score of dimensions of food fussiness, bad eating habits, and susceptible eating decreased. In addition, scores in food responsiveness, bad eating habits, and susceptible eating dimensions were significantly different among caregivers with different education levels ($P < 0.05$). Furthermore, scores in food responsiveness, food fussiness, bad eating habits, and restrained eating dimensions were different among children with variant family structures ($P < 0.05$). Scores were also different in various dimensions (except for food responsiveness and susceptible eating) among children with different body weights ($P < 0.05$). The scores of the enjoyment of food, appetite, food responsiveness, and junk food preference dimensions increased in higher weight categories, while food fussiness, bad eating habits, and restrained eating dimension scores decreased in higher weight categories. The scores were similar in all dimensions between men and women, among different places of residence, and with different family monthly incomes ($P > 0.05$).

**Table 4.** Comparison of each dimension score of the Chinese School-aged’ Children’s Eating Behavior Scale among different characteristics of children and caregivers in the third investigation of the scale (\(\cdot\))
|               | n  | Food fussiness | Food responsiveness | Appetite | Bad eating habit | Susceptible eating | Restained eating | Enjoyment of food | Junk food preference |
|---------------|----|----------------|---------------------|----------|------------------|--------------------|------------------|-------------------|---------------------|
| boys          | 354| 2.49±0.81      | 2.55±0.77           | 2.36±0.89| 2.16±0.71        | 2.23±0.60          | 1.75±0.81        | 3.26±0.74         | 2.75±0.80           |
| girls         | 330| 2.52±0.82      | 2.53±0.79           | 2.36±0.94| 2.06±0.65        | 2.25±0.62          | 1.81±0.78        | 3.26±0.78         | 2.69±0.76           |
| 6–8           | 151| 2.57±0.83      | 2.54±0.73           | 2.15±0.78| 2.17±0.64        | 2.32±0.60          | 1.72±0.72        | 1.67±0.73         | 2.76±0.72           |
| 9–10          | 298| 2.44±0.82      | 2.48±0.87           | 2.42±1.02| 2.01±0.65        | 2.16±0.64          | 1.80±0.80        | 1.81±0.81         | 2.67±0.85           |
| 11–12         | 235| 2.40±0.78      | 2.44±0.76           | 2.46±0.92| 1.87±0.59        | 2.11±0.57          | 1.99±0.89        | 1.77±0.80         | 2.72±0.77           |
| urban         | 370| 2.51±0.82      | 2.55±0.79           | 2.36±0.92| 2.11±0.68        | 2.25±0.61          | 1.78±0.80        | 3.27±0.77         | 2.72±0.78           |
| rural         | 314| 2.45±0.79      | 2.43±0.69           | 2.33±0.93| 1.99±0.66        | 2.19±0.63          | 1.82±0.75        | 3.21±0.80         | 2.67±0.74           |
| junior high school or less | 120| 2.46±0.74      | 2.42±0.71           | 2.32±0.92| 2.05±0.69        | 2.21±0.56          | 1.83±0.78        | 3.25±0.68         | 2.80±0.73           |
| senior high school | 249| 2.44±0.85      | 2.48±0.89           | 2.39±0.99| 2.02±0.66        | 2.16±0.64          | 1.84±0.85        | 3.22±0.80         | 2.70±0.84           |
| college or university or graduate | 315| 2.58±0.79      | 2.67±0.68<sup>c,d</sup> | 2.35±0.82| 2.28±0.67<sup>c</sup> | 2.36±0.59<sup>d</sup> | 1.69±0.75        | 3.20±0.73         | 2.73±0.71           |
| less than 3000 yuan | 110| 2.36±0.79      | 2.48±0.85           | 2.36±0.97| 2.15±0.68        | 2.17±0.64          | 1.81±0.76        | 3.19±0.80         | 2.79±0.79           |
| 3000 ~        | 330| 2.49±0.79      | 2.55±0.80           | 2.43±0.93| 2.13±0.68        | 2.27±0.61          | 1.78±0.82        | 3.26±0.71         | 2.71±0.77           |
| ≥5000         | 244| 2.57±0.84      | 2.55±0.74           | 2.30±0.87| 2.07±0.72        | 2.24±0.61          | 1.79±0.77        | 3.29±0.80         | 2.71±0.81           |
| nuclear family | 406| 2.45±0.79      | 2.48±0.75           | 2.36±0.91| 2.05±0.66        | 2.21±0.60          | 1.82±0.81        | 3.24±0.76         | 2.68±0.77           |
| stem family   | 201| 2.62±0.87<sup>e</sup> | 2.67±0.82<sup>e</sup> | 2.37±0.92| 2.25±0.73<sup>e</sup> | 2.31±0.61          | 1.65±0.76<sup>e</sup> | 3.28±0.77 <sup>e</sup> | 2.82±0.80           |
| single parent family | 77| 2.50±0.75      | 2.58±1.04           | 2.13±0.93| 2.23±0.68        | 2.33±0.82          | 1.82±0.67        | 3.51±0.80         | 2.55±0.69           |
| thinner       | 60 | 2.77±0.80      | 2.25±0.78           | 2.00±0.82| 2.41±0.78        | 2.22±0.56          | 2.01±0.88        | 2.95±0.74         | 2.26±0.74           |
| normal        | 531| 2.51±0.81<sup>f</sup> | 2.52±0.77           | 2.34±0.89<sup>f</sup> | 2.29±0.68<sup>f</sup> | 2.24±0.60          | 1.78±0.79<sup>f</sup> | 3.28±0.74<sup>f</sup> | 2.32±0.78<sup>f</sup> |
| Overweight/obesity | 93| 2.22±0.81<sup>f</sup> | 2.70±0.82<sup>g</sup> | 2.95±0.97<sup>f</sup> | 2.00±0.61<sup>f</sup> | 2.24±0.76          | 1.49±0.70<sup>f</sup> | 3.39±0.88<sup>f</sup> | 2.79±0.79<sup>f</sup> |

<sup>a</sup>Compared with the age group of 6 - 8 years old \( p < 0.05 \).
<sup>b</sup>Compared with the age group of 9 - 10 years old \( p < 0.05 \).
<sup>c</sup>Compared with the group of junior high school and below \( p < 0.05 \).
<sup>d</sup>Compared with the group of senior high school \( p < 0.05 \).
<sup>e</sup>Compared with the group of nuclear family \( p < 0.05 \).
<sup>f</sup>Compared with the group of thin \( p < 0.05 \).
<sup>g</sup>Compared with the group of normal \( p < 0.05 \).
Discussion

The current study developed a new scale (CSCEBS) to evaluate the eating behaviors of Chinese school-aged children. The final scale consisted of 46 items across 8 dimensions including food fussiness, satiety responsiveness, food responsiveness, bad eating habits, susceptible diet, restrained eating, enjoyment of food, and junk food addiction. CSCEBS showed good reliability and construct validity, and could be useful to measure the complex eating behaviors of Chinese school-aged children.

It is very difficult to accurately measure eating behaviors in children because there are many factors that can affect the behavior. Although a few countries have developed some standardized tools to assess the eating behaviors of children, these scales were mainly developed in European countries and the United States (US), and thus no commonly recognized structure of questionnaires exists to evaluate the eating behaviors of children in China. In addition, these questionnaires or scales focused on children in different age groups and with varying cultural backgrounds. For instance, the DEBQ-C was developed for Dutch children aged 7 to 12 years old [14, 15], and the CEBQ was designed for UK children aged 2 to 9 years old [13]. Similar to the CEBQ-C, our new scale included dimensions of responsiveness to food, enjoyment of food, food fussiness, and restrained eating; different from the CEBQ-C, our scale also included 5 other dimensions. A few dimensions from the CEBQ-C (desire to drink, slowness in eating, emotional eating, satiety responsiveness, exogenous eating, and susceptible eating) were not included as a single dimension in the current study; instead, they were incorporated with other items as a new dimension (junk food addiction, bad eating habits, susceptible eating, and appetite). Compared with DEBQ-C, the dimension of restrained eating was also extracted in our scale, exogenous eating was not extracted alone, but the dimension of susceptible eating included 5 items reflecting exogenous eating. Furthermore, the Chinese Preschool Children Eating Behavior Questionnaire (CPEBQ) was developed for preschool children aged 3 to 6 years old [18], and consisted of 38 items and 7 dimensions (food responsiveness, food fussiness, satiety responsiveness, eating habits, emotional eating, exogenous eating, and initiative eating). Compared to the CPEBQ, the CSCEBS has more dimensions and items. All of these differences among scales may be due to the different eating behaviors of children from different countries, regions, and age groups. Therefore, further studies are warranted to validate our scale among children in the same age group and cultural background.

The development of food preferences in children involves a complicated interaction of genetic, family, and environmental factors [36]. Although recent studies suggest that genetic influence could be a strong determinant of appetite in children, environmental factors are also important in determining eating behaviors of children. After assessing the factors associated with children's eating behavior, Scaglioni et al. [36] concluded that children's eating behaviors are influenced by genetics, family environment, social environment, and other factors. Another study evaluating the eating behaviors of Chinese children aged 6 to 12 years-old reported that sex, race, weight, and the educational levels of parents are associated with the eating behaviors of children [12]. Consistent with these two studies, the current study found significant variations in dimension scores among different education levels of caregivers, family structure, and children's weight [12, 36]. In addition, different eating behaviors have been found between adolescent boys and girls, but less is known about the starting age of gender difference [37]. Consistent with Wardle [37], our results showed that scores in all dimensions were similar between boys and girls, although these findings are partially different from those of Webber [12]. Among the 8 dimensions in the present scale, the scores for food fussiness, susceptible eating, and bad eating habits were inversely associated with age, and the score of restrained eating and appetite were positively associated with age. Our results are consistent with a UK study using the CEBQ [38], which indicated that eating behavior has attributes of stability and continuity in children. In addition, Nakao et al. [39] showed that the weight of a child correlates with his or her eating behavior at age 4 years. Our study showed that the scores of food fussiness, appetite, bad eating habits, restrained eating, food responsiveness, junk food preference, and enjoyment of food were significantly different among children with different BMI categories (thinner, normal weight, and overweight/obese), which corroborated previous findings that eating behavior is the key factor of childhood overweight and obesity [12]. However, different from previous studies [18, 20-24, 36], the score of each dimension did not differ by family income and places of residence. The heterogeneity may be due to the fact that the subjects recruited in the current study were from Shaanxi province, where the variations in economic levels among different regions, and between urban and rural areas, were smaller compared to previous studies.

Previous studies assessing eating behaviors among Chinese school-aged children have found that common eating behaviors among this population include food fussiness (26.7 - 77.3%), eating slow (43.3 - 46.4%), eating less (18.3 - 41.3%), food refusal (30.0 - 47.8%), unwilling to experiment with new foods (17.6 - 33.9%), favor foods with special type, color, texture, etc. (26.7 - 71.6%), no fixed site for eating (30.0 - 45.8%), multi-task while eating (32.2 - 60.1%), eating influenced by external factors (13.7 - 36.9%), emotional eating (8.6 - 16.8%), bad eating habits (54.2%), and eating high calorie food, high sugar food, etc. (47 - 70.0%) [20-24]. The 8 dimensions of the CSCEBS developed in the current study (food fussiness, food responsiveness, satiety responsiveness, bad eating habits, susceptible diet, restrained eating, enjoyment of food, and junk food addiction) covered all the above-mentioned common eating behaviors among school-aged children in China. Therefore, our results highlight that the CSCEBS is suitable for assessing the eating behaviors among this population.

Our results have important clinical implications. Evaluating eating behaviors is crucially informative for developing intervention programs to provide education for children with problematic eating behaviors, as well as their families. A higher dimension score suggests that the child is more likely to have problematic eating behavior in this dimension. The CSCEBS is a useful and convenient tool, and could be widely applied to
all hospitals, healthcare centers, and schools in China. Using the CSCEBS, childcare workers or pediatricians could quickly identify eating problems and develop targeted interventions and support for children and their families.

The current study has some strengths that should be noted. The CSCEBS was developed by integrating information from other Chinese, European, and US scales, and effectively combined overlapping and different dimensions of content from these scales. We used comprehensive statistical analyses to develop and evaluate the psychometric properties of the scale. For example, we performed both exploratory and confirmed factor analyses, and grouped a few dimensions from previous studies [31-33] into one dimension in the current study, which made the scale more representative and targeted for the current population. However, several limitations of our scale merit consideration. First, children's eating behaviors varied between regions and were multifactorial, with distinct differences across locations and ethnicities [10, 36, 40, 41]. Since the current study was conducted in Shaanxi province, it is possible that the scale did not capture eating behaviors that are unique in other regions of China. Second, participants were selected from three cities (Xi’an, Hanzhong, and Yanan) and therefore the findings might not represent other cities in the same province or other provinces in China. Furthermore, since there is no “gold standard” tool or a generally accepted tool to measure school-aged children's eating behaviors in China, the criterion validity was not assessed. Given that eating behaviors may vary with cultural background and that the prevalence of childhood obesity has been increasing in China, validation studies among other populations are vital to confirm our findings. Future studies are warranted to confirm the reliability and validity of this scale in other geographical regions and ethnic groups in China.

Conclusions
To the best of our knowledge, we are the first to develop a scale to measure the eating behaviors among school-aged children in China. The scale is a theory- and evidence-based tool for assessing school-aged children's eating behaviors. We demonstrated that our scale was reliable and valid with good discriminative ability in a population of school-aged children in China. Future studies should confirm existing findings in different Chinese populations with larger sample sizes. Additional studies are needed to explore how eating behavior influences children's weight and identify effective strategies to prevent childhood obesity.

List Of Abbreviations
WGOC: Chinese Obesity Working Group; CEBQ: Children's Eating Behaviour Questionnaire; DEBQ-C: Dutch Eating Behaviour Questionnaire for Children; CSCEBS: Chinese School-aged Children's Eating Behavior Scale; CPEBQ: Chinese Preschool Children Eating Behavior Questionnaire; SRMR: standardized root mean squared residual; AGFI: adjusted goodness-of-fit index; GFI: the goodness-of-fit index; CFI: comparative fit index; NNFI: non-normed fit index; RMSEA: root mean square error of approximation; JA: junk food addiction; BH: bad eating habits; FF: food fussiness; SD: susceptible diet; RE: restrained eating; EF: enjoyment of food; FR: food responsiveness; AP: appetite

Declarations
Ethics approval and consent to participate
The Ethics Committee of the Fourth Military Medical University approved the current study. Written informed consent was provided by all recruited caregivers prior to the study, and the study complied with related regulations and guidelines. Data was collected anonymously.

Consent for publication
All participants have given informed consent and have given consent for publication.

Availability of data and materials
The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Competing interests
The authors declare that they have no competing interests.

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Authors’ contributions
LS and XJ conceived the study and led the writing of the manuscript. All authors designed the study and reviewed versions of the protocol. HZ, YHZ, JY, ZJT and TX organized and supervised the data collection phase of the study. HZ, YHZ and JY conducted the data analysis and also participated in writing the manuscript. LS and XJ analyzed and interpreted the results and led the writing of the manuscript. All authors critically reviewed the manuscript and provided comments for revision. All authors read and approved the final version of the manuscript.

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