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ORIGINAL RESEARCH

Caregivers' feeding behaviour, children's eating behaviour and weight status among children of preschool age in China

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Abstract

Background: Childhood overweight and obesity have become significant public health challenges worldwide. The present study aimed to investigate whether caregivers' feeding behaviour and children's eating behaviour were associated with the weight status of preschool children in China.

Methods: A cross-sectional questionnaire was administered to 912 caregivers of preschool children from April to July 2016. Caregivers' feeding behaviours were assessed by the Chinese Preschooler's Caregiver Feeding Behaviour Scale. Children's eating behaviours were evaluated using the Chinese Preschooler's Eating Behaviour Questionnaire. After controlling for demographic characteristics, multiple linear regression and logistic regression analyses were performed to evaluate the relationship between caregivers' feeding behaviour, children's eating behaviour and children's body mass index (BMI).

Results: The results showed that weight concerns on the part of caregivers ($\beta = 0.53$) and food responsiveness on the part of children ($\beta = 0.93$) were positively correlated with children's BMI, whereas caregivers' responsibility for feeding ($\beta = -0.68$) and children's external eating ($\beta = -0.53$) were negatively correlated with BMI. Among caregiver feeding behaviours, weight concerns [odds ratio (OR) =4.54, $p < 0.001$] and behaviour-restricted feeding (OR =0.29, $p < 0.001$) were positively correlated with children's BMI. A child's food responsiveness (OR =4.04, $p < 0.001$) was also positively correlated with his/her BMI, whereas the child's satiety responsiveness (OR =0.42, $p < 0.001$) and emotional eating habits (OR =0.56, $p < 0.001$) were negatively correlated with overweight/obesity status.

Conclusions: Our study demonstrated that children's eating behaviour and caregivers' feeding behaviour were associated with weight status among preschool children in China. Behaviour interventions on caregivers and their children may prevent or reduce weight problems in preschool children.

KEYWORDS
BMI, eating behaviour, feeding behaviour, overweight/obesity, preschool children

Jing Yuan, Xun Jiang and Tongyu Zhu equally contributed to this study.

INTRODUCTION

Overweight and obesity have become serious public health challenges worldwide in recent years.[1–5] A systematic analysis reported that the rates of overweight/obesity in developing and developed countries were 13% and 24%, respectively, in 2013.[4] The Nutrition and Chronic Diseases of Chinese Residents Report in 2015 showed that the prevalence of overweight and obesity in children < 6 years of age was 8.4% and 3.1%, respectively, and these rates are increasing.[2,6] Childhood overweight and obesity are closely related to the occurrence of chronic diseases such as hypertension, diabetes and coronary heart disease[3,5] and also have a negative association with mental health, intellectual and learning abilities, personality development and psychosocial well-being.[1]

Recent increases in the rates of childhood obesity and associated health risks have drawn the attention of scientists.[4,7–9] Ek *et al.* [10] showed that the occurrence of overweight and obesity was closely correlated with both feeding practices and eating behaviours. Moreover, previous evidence showed that the age range of 3–6 years is a critical period for the maturation of healthy eating behaviours and the prevention of childhood obesity.[11,12] At these ages, children begin to develop their eating habits,[13] which are strongly affected by the caregivers' feeding behaviour.[11,12] Caregivers control children's food intake by establishing routines for when, what and how their children eat and drink, as well as how the food and drinks are served.[14] Some studies have confirmed that inappropriate feeding practices lead to the development of unhealthy eating patterns in children, such as partial eclipse (having a preference for certain types of food), picky eaters (only eating food he/she likes without considering nutrition) and anorexia (lack or loss of appetite), resulting in increased rates of childhood overweight and obesity.[15–17] Although the caregiver's feeding behaviour plays an important role in the development of unhealthy eating patterns in children, other factors that may contribute to the changes in children's eating patterns and weight status should also be acknowledged. Preschool years (3–6 years old) are a critical period for the prevention of childhood obesity.[13,18,19] The identification of promising intervention strategies requires a thorough understanding of the modifiable factors contributing to overweight and obesity in children.

At present, most studies based on samples from European[12,20] and North American populations[21,22] report associations between caregivers' feeding behaviour, children's eating behaviour and body weight. It has been shown that food-related behaviours among caregivers and children vary greatly across cultures.[19,23] The association among caregiver's feeding behaviour, children's eating behaviours and body weight may be different in China compared to other countries. The association of these factors has not been well studied in Chinese children of preschool age. Thus, the present study aims to investigate whether caregivers' feeding practices and children's eating behaviours are correlated with weight status in preschool children. Our results may support the development of early interventions for obesity prevention in children.

METHODS

Subjects

The experimental protocol was approved by the University Research Ethics Committee (16 November 2018) and all procedures were performed in accordance with the relevant regulations and guidelines. Written informed consent was obtained from all recruited caregivers prior to the study, and data were collected anonymously. In total, 912 preschool children (3–6 years old) and their primary caregivers were recruited from five kindergartens in the urban and suburban areas of Xi'an and Jinan City in China during the period from April to July 2016 using a stratified sampling method at each kindergarten. The primary caregiver was defined as the person who was responsible for the majority of care/feeding (activity, diet, sleep, etc.), and had cared for the child for the longest time at home. This person could be the child's parent, grandparent or nanny. Each recruited caregiver provided their written informed consent before data were collected. All data were collected anonymously.

The inclusion criteria were: (i) age 3–6 years and (ii) caregiver agreed to participate and answer the questionnaire. The exclusion criteria were: (i) children with a history of chronic disease (e.g., constipation, chronic gastritis, chronic diarrhea, toddler's diarrhea) that might have influenced his/her eating behaviour over the last two months and (ii) caregiver unwilling to participate in the study or unable to communicate.

Study instruments

Caregivers' feeding behaviours were assessed using the Chinese Preschooler's Caregivers' Feeding Behaviour Scale (CPCFBS).[24] The CPCFBS comprises seven dimensions and 35 items. Dimension 1 – Responsibility Feeding reflects the feeding behaviours caused by caregivers' responsibility to maintain a healthy diet during feeding. Dimension 2 – Weight Concerns evaluates the association between parental worry on children's weight and their daily feeding behaviours. Dimension 3 – Encourage Healthy Feeding describes behaviours that encourage healthy eating. Dimension 4 – Content-Restricted Feeding and dimension 5 – Behaviour-Restricted Feeding assesses the limits set by the caregiver on food composition and eating behaviours. Dimension 6 – Forced Feeding measures the association between mandatory feeding practices and the children's healthy eating behaviours. Dimension 7 – Supervise Eating evaluates the association between caregiver monitoring and children's unhealthy eating patterns. Test–retest reliability was 0.85 and Cronbach's α coefficient for the total scale was 0.91. The construct validity of the scale was evaluated by factor analysis. Our previous analysis of reliability and validity showed

that the seven dimensions of this scale explained 58.6% of total variance in caregivers' feeding behaviour.[24]

Children's eating behaviours were evaluated with the Chinese Preschoolers' Eating Behaviour Questionnaire (CPEBQ), which consists of seven dimensions and 38 items.[25] Dimension 1 – Food Fussiness examines whether the child refuses food because of its taste, appearance, smell, or texture. Dimension 2 – Food Responsiveness assesses the child's desire to eat. Dimension 3 – Eating Habits detects unhealthy eating habits, such as watching television or playing with toys while waiting a long time for meals. Dimension 4 – Satiety Responsiveness evaluates satiety sensitivity. Dimension 5 – Exogenous Eating evaluates the child's response to external factors that might affect his/her eating. Dimension 6 – Emotional Eating assesses eating status when the child experiences negative emotions. Dimension 7 – Initiative Eating evaluates whether the child is able to eat independently. The CPEBQ has been shown to have good reliability and validity in Chinese children of preschool age.[25] The test–retest reliability was 0.72. The Cronbach's α coefficient for the entire scale was 0.92. The construct validity of the CPEBQ was evaluated by factor analysis. Our previous analysis of reliability and validity showed that the seven dimensions of this questionnaire explained 57.0% of the total variance in children's eating behaviour.[25]

The items in both scales evaluated feeding practices or eating behaviours that occurred over the 3 months leading up to the study. There were five options available for each item: never, rarely, sometimes, often and always, which were assigned scores of 1, 2, 3, 4 and 5, respectively. The average score for each dimension was calculated as the sum of the scores for each item divided by the number of items included in that dimension. Overall, higher scores indicated more engaged eating or feeding behaviours.

Demographic data including caregivers' age and educational level, total monthly household income, children's gender, children's age and the nature of the child–caregiver relationship were also collected. The height and weight of both caregivers and children were measured by an investigator at the kindergarten with standardised anthropometric protocols. BMI was calculated as: BMI = weight (kg)/height (m^2). All enrolled children were classified into four groups according to the BMI standards published by the Centre for Disease Control of China[26]: underweight (sex- and age-specific BMI < 15th percentile), normal weight (sex- and age-specific BMI between the 15th and 85th percentiles), overweight (sex- and age-specific BMI between the 85th and 95th percentiles) and obese (sex- and age-specific BMI >95th percentile). Caregivers were categorised into four groups: underweight (BMI < 20), normal weight (BMI between 20 and 24), overweight (BMI between 24 and 28) and obese (BMI > 28).[27] The educational level of caregivers was classified as junior high school or below, senior high school or college/university and above. The 25th percentile (P_{25}), 50th percentile (P_{50}) and 75th percentile (P_{75}) values for scores on the CPCFBS and CPEBQ were calculated, and the scores of all dimensions in these two scales were converted into four grades, by quartile (P_{25}, P_{50} and P_{75}).

Investigation and quality control

Caregivers recruited from each kindergarten were congregated in a single classroom. An investigator explained the aims and detailed requirements of the study to the caregivers. Then, the questionnaires were distributed to all caregivers. The completed questionnaires were collected by the investigator.

All of the questionnaires were administered by five paediatricians who had at least 5 years of experience in paediatric practice. All of the investigators were trained by paediatricians before the study to ensure that they fully understood the purpose, significance and requirements of the questionnaire, the meaning of all items in each subscale, and the physical examination methods. All completed questionnaires were carefully reviewed by the primary investigator. If the questionnaire was not complete, telephone interviews were conducted to collect missing information. A database was established using EpiData, version 3.1 (EpiData Association). To ensure data accuracy, a logic error-check was performed and a double-entry mode was used.

Statistical analysis

Statistical analyses were performed using SPSS, version 21 (IBM Corp.). $p < 0.05$ was considered statistically significant. Qualitative data are expressed as frequencies and percentages. Quantitative data are shown as the mean ± SD. Multiple linear stepwise regression was used to investigate the factors associated with abnormal BMI. Demographic characteristics and CPCFBS and CPEBQ scores were defined as independent variables (X). The child's BMI was defined as the dependent variable (Y) (see Supporting information, Appendix S1). Progressive advance logistic regression analysis was used to screen for factors associated with overweight/obesity in children. The demographic characteristics and CPCFBS and CPEBQ scores in seven dimensions were defined as the independent variables (X). The child's weight status (overweight or obese) was defined as the dependent variable (Y) (see Supporting information, Appendix S2). The inclusion criterion for the two regression analyses was $p < 0.05$. The rejection criterion was $p > 0.10$. The degree of interpretation of the independent variables in the model was determined by the model's determination coefficient, r^2. The larger the value of r^2, the better the model fit.

RESULTS

Characteristics of the children included in the study and their caregivers

Among 912 primary caregivers, valid questionnaires were collected from 768 participants (response rate = 84.2%). The characteristics of the children and caregivers are shown in Table 1. The mean ± SD age of the recruited

children was 4.9 ± 0.9 years. Among them, 52.0% resided in urban areas and 53.4% were boys. The majority of these children (66.8%) had normal weight. The rates of underweight, overweight and obesity among these children were 10.0%, 12.5% and 10.7%, respectively. The prevalence rates of underweight, overweight and obesity were higher in children who lived in urban areas compared to those residing in rural areas ($\chi^2 = 25.506$, $p = 0.013$). Gender differences were found in the weight status of children ($\chi^2 = 15.595$, $p < 0.001$). Gender was a variable with an influence not only on weight obesity, which was more prevalent in the 3–4-year-old age group, but also in those whose main caregiver was a grandparent ($\chi^2 = 20.53$, $p < 0.001$).

TABLE 1 Demographic characteristics of the children and their caregivers

		Weight status of childrene ($n = 768$)				
Group	**Total**	**Underweight[a] ($n = 77$)**	**Normal weight[b] ($n = 513$)**	**Overweight[c] ($n = 96$)**	**Obesity[d] ($n = 82$)**	***p***
Urban/rural (%)						
Urban	52.0	55.8	61.4	63.5	54.9	0.013
Rural	48.0	44.2	38.6	36.5	45.1	
Child sex						
Male	53.4	44.2	50.5	67.7	63.4	< 0.001
Female	46.6	55.8	49.5	32.3	36.6	
Child age (years) (%)						
3	31.5	23.4	29.0	40.6	64.6	< 0.001
4	33.5	26.0	36.7	21.9	26.9	
> 5	35.0	50.6	34.3	37.5	8.5	
Child–caregiver relationship (%)						
Parent	76.2	85.7	77.6	77.1	57.3	< 0.001
Grandparent and others	23.8	14.3	22.4	22.9	42.7	
Caregiver age (years) (%)						
20–29	11.5	18.2	11.3	8.3	9.8	0.005
30–30	62.2	55.8	65.3	63.5	47.6	
40–49	7.4	13.0	5.9	8.3	10.9	
> 50	18.9	13.0	17.5	19.8	31.7	
Caregiver weight status (%)						
Underweight[e]	8.7	15.6	7.6	5.2	13.4	0.028
Normal weight[f]	45.1	36.4	47.6	48.9	32.9	
Overweight[g]	35.5	41.5	34.3	31.3	42.7	
Obesity[h]	10.7	6.5	10.5	14.6	11.0	
Caregiver education(%)						
Junior high school or below	27.6	28.6	26.5	27.1	34.2	< 0.001
Senior high school	25.4	28.6	22.2	18.7	50.0	
College/university or above	47.0	42.8	51.3	54.2	15.8	
Family monthly income(%)						
< $750	45.6	63.6	45.6	33.3	43.9	0.002
$750 to $1500	43.8	27.3	43.1	53.2	51.2	
> $1500	10.7	9.1	11.3	13.5	4.9	

[a]Sex- and age-specific body mass index (BMI) <15th percentile.
[b]Sex- and age-specific BMI between the 15th and 85th percentiles.
[c]Sex- and age-specific BMI between the 85th and 95th percentiles.
[d]Sex- and age-specific BMI >95th percentile.
[e]BMI < 18.5.
[f]BMI between 18.5 and 24.
[g]BMI between 24 and 28.
[h]BMI > 28.

CPCFBS and CPEBQ scores

The mean scores on each dimension of the CPCFBS and CPEBQ are presented in Tables 2 and 3. For the CPCFBS, scores were highest on the Supervised Eating dimension, followed by Responsibility Feeding and Encouraging Healthy Feeding. These results suggested that most caregivers performed their responsibilities during the feeding process. For the CPEBQ, scores were highest on the Initiative Eating and External Eating dimensions.

Except for Forced Feeding ($p < 0.05$), average scores on various dimensions of the CPCFBS differed significantly among children with different weight. Scores on the Weight Concerns dimension increased in overweight/obese children, whereas the results for Responsibility Feeding and Encouraging Healthy Feeding showed the opposite trend. For the CPEBQ, average scores on the Food Responsiveness, Food Fussiness, Eating Habits, Emotional Eating and Initiative Eating dimensions were significantly different among children who differed in terms of weight status ($p < 0.05$). Scores on the Food Responsiveness, Eating Habits and Emotional Eating dimensions increased in association with weight gain.

Association among feeding behaviours, eating behaviours and children's BMI

The results of multivariate linear stepwise regression analysis using BMI as the dependent variable (Y), the demographic characteristics (children's gender, children's age, caregivers' age, child–caregiver relationship, caregivers' educational level, monthly household income) and scores on the CPCFBS and CPEBQ as independent variables (X) are shown in Table 4. According to Model 1, in which demographic characteristics were independent variables, the factors associated with abnormal BMI were the child's gender (β = 1.01), the child's age (β = −1.29), caregiver educational level (β = −1.45) and monthly household income (β = 0.72; $F = 25.04$, $p < 0.001$). The model determination coefficient r^2 was 0.371. In Model 2, the demographic characteristics and caregivers' feeding behaviours were used as independent variables. The factors associated with BMI included child's gender (β = 1.07), child's age (β = −1.08), caregivers' educational level (β = −1.11), monthly household income (β = 0.65), Responsibility for Feeding (β = −0.87) and Weight Concerns (β=0.69) on the CPCFBS ($F = 24.46$, $p < 0.001$). The model determination coefficient (r^2) was 0.484. In Model 3, the

TABLE 2 Average scores on each dimension of the Chinese Preschooler's Caregivers' Feeding Behaviour Scale in children, stratified by weight status

Behaviours	Underweight	Normal	Overweight	Obesity	Total
Responsibility feeding (X_{RF})	4.00 ± 0.57	3.92 ± 0.67	3.72 ± 0.69[a,b]	3.47 ± 0.77[a,b,c]	3.85 ± 0.69
Weight concerns (X_{WEC})	1.73 ± 0.84[b,c]	2.12 ± 0.92[a,c]	2.49 ± 0.94[a,b]	2.56 ± 0.73[a,b]	2.17 ± 0.93
Encourage healthy feeding (X_{EHF})	3.90 ± 0.56[c]	3.87 ± 0.62[c]	3.63 ± 0.68[a,b]	3.36 ± 0.69[a,b,c]	3.79 ± 0.65
Content-restricted feeding (X_{CTRF})	3.50 ± 0.89	3.66 ± 0.81[c]	3.47 ± 0.86[b]	3.45 ± 0.68[b]	3.59 ± 0.81
Behaviour-restricted feeding (X_{BHRF})	3.63 ± 0.85	3.72 ± 0.75	3.50 ± 0.74[b]	3.31 ± 0.68[a,b]	3.64 ± 0.76
Forced feeding (X_{FOF})	3.40 ± 0.83	3.55 ± 0.83	3.43 ± 0.70	3.48 ± 0.65	3.51 ± 0.82
Supervise eating (X_{SE})	3.97 ± 0.82	3.99 ± 0.77	3.81 ± 0.79	3.63 ± 0.80[a,b]	3.92 ± 0.82

[a] $P \leq 0.05$ vs. underweight.
[b] $P \leq 0.05$ vs. normal weight.
[c] $P \leq 0.05$ vs. overweight.

TABLE 3 Average scores on each dimension of the Chinese Preschoolers' Eating Behaviour Questionnaire in children, stratified by weight status

Behaviours	Underweight	Normal	Overweight	Obesity	Total
Food fussiness (X_{FF})	2.48 ± 0.55[c]	2.56 ± 0.55	2.68 ± 0.47[a]	2.69 ± 0.48[a,b]	2.58 ± 0.54
Food responsiveness (Y_{FR})	2.20 ± 0.53[b,c]	2.38 ± 0.63[a,c]	2.53 ± 0.57[a,b]	2.77 ± 0.68[a,b,c]	2.43 ± 0.65
Eating habit (X_{EH})	2.29 ± 0.68[c]	2.37 ± 0.66[c]	2.54 ± 0.63[a,b]	2.71 ± 0.59[a,b]	2.42 ± 0.67
Satiety responsiveness (X_{SR})	2.69 ± 0.54	2.70 ± 0.53	2.67 ± 0.50	2.81 ± 0.53	2.71 ± 0.54
External eating (X_{EXE})	2.82 ± 0.64	2.95 ± 0.65	2.90 ± 0.67	2.87 ± 0.60	2.92 ± 0.65
Emotional eating (X_{EE})	1.80 ± 0.67	1.95 ± 0.75	2.28 ± 0.87[a,b]	2.47 ± 0.80[a,b]	2.03 ± 0.79
Initiative eating (X_{IE})	3.90 ± 0.75[c]	3.76 ± 0.68	3.64 ± 0.69[a]	3.50 ± 0.61[a,b]	3.73 ± 0.69

[a] $P \leq 0.05$ vs. underweight.
[b] $P \leq 0.05$ vs. normal weight.
[c] $P \leq 0.05$ vs. overweight.

TABLE 4 The association between caregivers' feeding behaviour, children's eating behaviour and children's body mass index

Model	Partial regression coefficient β	Standardised partial regression coefficient	95% CI		*p* value	r^2
			Lower limit	Upper limit		
Model 1					0.000	0.371
Child sex	1.01	0.12	1.02	1.57	0.001	
Child age (years)	−1.29	−0.30	−1.58	−1.01	0.000	
Caregivers' education						
Senior high school	0.02	0.02	–	–	0.579	
College/university or above	−1.45	−0.17	−2.03	−0.86	0.000	
Family monthly income						
$750 to $1500	0.72	0.09	0.02	0.12	0.019	
> $1500	0.06	0.05	–	–	0.148	
Model 2					0.000	0.484
Child sex	1.07	0.13	1.02	1.61	0.000	
Child age (years)	−1.08	−0.25	−1.37	−0.79	0.000	
Caregivers' education						
Senior high school	0.04	0.02	–	–	0.36	
College/university or above	−1.11	−0.13	1.02	1.61	0.000	
Family monthly income						
$750 to $1500	0.65	0.12	0.02	0.17	0.042	
> $1500	0.06	0.05	–	–	0.148	
RF	−0.87	−0.14	−1.27	−0.47	0.000	
WEC	0.69	0.15	0.39	0.99	0.001	
Model 3					0.000	0.601
Child sex	1.06	0.27	1.05	1.60	0.000	
Child age (years)	−1.01	0.23	−1.31	−0.72	0.000	
Caregivers' education						
Senior high school	−0.05	0.07	–	–	0.196	
College/university or above	−1.12	−0.13	−1.65	−0.58	0.000	
Family monthly income						
$750 to $1500	0.68	0.12	0.06	0.13	0.033	
> $1500	0.08	0.11	–	–	0.108	
RF	−0.68	−0.11	−1.08	−0.27	0.003	
WEC	0.53	0.12	0.22	0.84	0.001	
FR	0.93	0.15	1.04	1.41	0.000	
EXE	−0.53	−0.08	−0.97	−0.09	0.001	

Note:: (1) Model 1 used demographic characteristics as independent variables; Model 2 used demographic characteristics and Chinese Preschooler's Caregivers' Feeding Behaviour Scale scores as independent variables; Model 3 used demographic characteristics, Chinese Preschooler's Caregivers' Feeding Behaviour Scale scores and Chinese Preschoolers' Eating Behaviour Questionnaire scores as independent variables. (2) For classification variables, gender of the child, educational level of the caregiver and monthly family income were analysed based on 'female', 'junior high school or below' and 'under $750', respectively. (3) Data were analysed using the multivariate stepwise linear regression method.

Abbreviations: CI, confidence interval; FR, food responsiveness; EXE, external eating; RF, restricted feeding; WEC, weight concerns.

demographic characteristics, caregivers' feeding behaviours and children's eating behaviours were used as independent variables. The results showed that the factors associated with BMI were child's gender (β = 1.06), child's age (β = −1.01), caregivers' educational level (β = −1.12), monthly household income (β = 0.68), Responsibility for Feeding (β = −0.68) and Weight Concerns (β = 0.53) on the CPCFBS, as well as Food Responsiveness (β = 0.93) and External Eating (β = −0.53) on the CPEBQ ($F = 21.18$, $p < 0.001$). The model determination coefficient (r^2) was 0.601. Moreover, BMI was higher among boys compared to girls ($p \leq 0.001$). Family monthly income and scores on the Weight Concerns and Food Responsiveness dimensions were positively correlated with children's BMI ($p < 0.05$). Children's age, caregivers' educational level, Responsibility for Feeding score on the CPCFBS and External Eating Behaviour in children were negatively

correlated with children's BMI ($p < 0.05$). A lower BMI was observed in younger children, in caregivers with higher educational levels and in subjects with higher scores on the Responsibility for Feeding and External Eating subscales.

Association among feeding behaviours, eating behaviours and children's weight status

In the binary logistic regression analysis, abnormal weight status (overweight/obesity) was used as the dependent variable (Y). The demographic characteristics (child gender, age, caregiver age, relationship with child, caregiver education, family monthly total income) and scores on the CPCFBS and CPEBQ were independent variables (X) (Table 5). According to Model 1, in which demographic characteristics were the independent variables, the factors associated with overweight/obesity included caregivers' educational level [odds ratio (OR) = 0.49, $p < 0.001$], monthly family income (OR = 3.01, $p < 0.001$) and children's age (OR = 0.42, $p < 0.001$) ($\chi^2 = 68.29$, $df = 6$, $p < 0.001$). In Model 2, demographic characteristics and caregivers' feeding behaviours were the independent variables. The factors associated with overweight/obesity were family monthly income (OR = 2.02, $p < 0.001$), Responsibility for Feeding (OR = 0.44, $p < 0.001$), Weight Concerns (OR = 5.36, $p < 0.001$), Behaviour-Restricted Feeding (OR = 0.53, $p < 0.001$) and Supervised Eating (OR = 0.52, $p < 0.001$) on the CPCFBS ($\chi^2 = 218.76$, $df = 13$, $p < 0.001$). According to Model 3, in which demographic characteristics, caregivers' feeding behaviours and children's eating behaviours were the independent variables, the factors associated with overweight/obesity were monthly family income (OR = 1.76, $p < 0.001$), Weight Concerns (OR = 4.54, $p < 0.001$), Behaviour-Restricted Feeding (OR = 0.29, $p < 0.001$) on the CPCFBS, as well as Food Responsiveness (OR = 4.04, $p < 0.001$), Satiety Responsiveness (OR = 0.42, $p < 0.001$) and Emotional Eating (OR = 0.56, $p < 0.001$) on the CPEBQ ($\chi^2 = 244.96$, $df = 17$, $p < 0.001$). The model determination coefficient (r^2) was 0.666. Furthermore, family monthly income, as well as scores on the Weight Concerns, Behaviour-Restricted Feeding and Food Responsiveness dimensions, were positively correlated with overweight/obesity status in children ($p < 0.05$). The higher the score on a given dimension, the higher the risk for overweight/obesity in children. Scores on the Satiety Responsiveness and Emotional Eating subscales were negatively correlated with abnormal weight status in children ($p < 0.05$). A higher likelihood of overweight/obesity was observed in participants with more monthly family income, with higher scores on the Weight Concerns and Behaviour-Restricted Feeding subscales on the CPCFBS, as well as higher scores on the Food Responsiveness subscale on the CPEBQ. A higher likelihood of overweight/obesity was also observed in participants with lower scores on the Satiety Responsiveness and Emotional Eating subscale on the CPEBQ ($p < 0.05$).

DISCUSSION

The identification of factors associated with weight status can optimise early intervention strategies to prevent childhood obesity. Recent studies have reported that demographic characteristics, such as children's age,[28] family environment,[29] caregivers' feeding behaviour[12,13,30–33] and children's eating behaviour,[10] are closely related to children's weight status. Furthermore, parental feeding practices are partially responsible for the relationship between children's eating behaviours and their BMI. On the other hand, children's eating behaviours explain part of the association between parental feeding behaviours and children's BMI.[13] Our multiple linear regression and binary logistic regression analyses consistently showed that children's weight status was associated with family demographic characteristics, children's eating behaviour and caregivers' feeding behaviour.

Association between family demographic characteristics and weight in children

Nowicka *et al.*[34] examined the psychometric properties of the Child Feeding Questionnaire (CFQ) and explored the relationship between parenting practices and children's weight status in Sweden.[35] The results showed that children's BMI and parents' foreign origin had a direct impact on restriction, and the pressure to eat was also affected by parental educational level. In 2014, Moreira *et al.*[29] confirmed the association between children's gender, children's age, child–caregiver relationship, family economic status and weight in children by analysing the data collected from the CFQ and the Overt and Covert Control Scale using linear regression analysis. They reported that family environment and maternal socio-economic factors were associated with the pressure to eat and perceived monitoring, whereas maternal health behavioural characteristics were associated with restriction. Rodenburg *et al.*[36] also found that socio-demographic variables, such as the child's ethnicity and the primary caregiver's educational level, were correlated with psychological control and the child's BMI. Using the Child Eating Behaviour Questionnaire (CEBQ), Alshammary *et al.*[19] found that obesogenic eating behaviours were associated with excess weight in both children and parents.

In the present study, the linear regression model showed that a child's gender, his or her age, caregiver's educational level and monthly household income were the main factors associated with BMI in children. BMI was higher in boys than girls. Higher caregiver educational level was associated with lower BMI values in children. These findings indicate that Chinese caregivers with lower monthly household incomes and higher educational levels are more likely to be concerned about childhood obesity. Their feeding practices were not associated with high BMI, indicating that these behaviours may reduce the risk of childhood obesity.

TABLE 5 The association between caregivers' feeding behaviour, children's eating behaviour, and children's overweight/obesity status

Model	Regression coefficient β	OR	OR 95% CI		*p* value	r^2
			Lower limit	Upper limit		
Model 1					0.000	0.314
Caregivers' education					0.001	
Junior high school or below	–	–	–	–	–	
Senior high school	−0.06	0.94	0.62	1.43	0.783	
College/university or above	−0.71	0.49	0.33	0.75	0.001	
Family monthly income					0.000	
≤ $750	–	–	–	–	–	
> $750 to ≤ $1500	1.10	3.01	2.09	4.33	0.001	
> $1500	0.66	1.94	1.12	3.36	0.018	
Child age (years)					0.000	
3	–	–	–	–	–	
4	−0.62	0.54	0.37	0.77	0.001	
5-6	−0.86	0.42	0.29	0.61	0.000	
Model 2					0.000	0.432
Family monthly income					0.001	
≤ $750	–	–	–	–	–	
> $750 to ≤ $1500	0.71	2.02	1.42	2.89	0.000	
> $1500	0.36	1.44	0.82	2.53	0.010	
RF					0.005	
< P_{25}	–	–	–	–	–	
P_{25}~	−0.42	0.65	0.40	1.07	0.092	
P_{50}~	−0.82	0.44	0.27	0.73	0.002	
≥ P_{75}	−0.89	0.41	0.23	0.72	0.002	
WEC					0.000	
< P_{25}	–	–	–	–	–	
P_{25}~	0.57	1.71	1.01	3.12	0.048	
P_{50}~	1.68	5.36	3.30	8.72	0.000	
≥ P_{75}	2.15	8.54	4.69	15.54	0.000	
BHRF					0.001	
< P_{25}	–	–	–	–	–	
P_{25}	−0.57	0.95	0.57	1.55	0.023	
P_{50}	−0.63	0.53	0.33	0.86	0.010	
≥ P_{75}	−0.98	0.38	0.22	0.64	0.000	
SE					0.041	
< P_{25}	–	–	–	–	–	
P_{25}	−0.28	0.76	0.48	1.19	0.228	
P_{50}	−0.65	0.52	0.29	0.93	0.027	
≥ P_{75}	0.13	1.14	0.65	1.99	0.042	
Model 3					0.000	0.666
Family monthly income					0.012	
≤ $750	–	–	–	–	–	
> $750 to ≤ $1500	0.56	1.76	1.21	2.56	0.003	
> $1500	0.24	1.28	0.70	2.31	0.023	

(Continues)

TABLE 5 (Continued)

Model	Regression coefficient β	OR	OR 95% CI		*p* value	r^2
			Lower limit	Upper limit		
WEC					0.000	
$< P_{25}$	–	–	–	–	–	
P_{25}	0.61	1.84	1.03	3.29	0.040	
P_{50}	1.51	4.54	2.73	7.55	0.000	
$\geq P_{75}$	1.79	5.97	3.20	11.12	0.000	
BHRF					0.000	
$< P_{25}$	–	–	–	–	–	
P_{25}	−0.20	0.98	0.58	1.64	0.039	
P_{50}	−0.71	0.49	0.31	0.78	0.003	
$\geq P_{75}$	−1.25	0.29	0.17	0.47	0.000	
FR					0.000	
$< P_{25}$	–	–	–	–	–	
P_{25}	0.14	1.15	0.72	1.82	0.559	
P_{50}	1.39	4.04	2.05	7.97	0.000	
$\geq P_{75}$	1.52	1.69	1.02	2.81	0.044	
SR					0.025	
$< P_{25}$	–	–	–	–	–	
P_{25}	−0.37	0.69	0.44	1.07	0.099	
P_{50}	−0.53	0.59	0.36	0.97	0.036	
$\geq P_{75}$	−0.88	0.42	0.23	0.76	0.004	
EE					0.000	
$< P_{25}$	–	–	–	–	–	
P_{25}	−0.58	0.56	0.34	0.91	0.019	
P_{50}	−0.18	1.19	2.04	0.69	0.014	
$\geq P_{75}$	−0.65	1.91	3.62	1.01	0.048	

Note:: (1) Model 1 used demographic characteristics as independent variables; Model 2 used demographic characteristics and Chinese Preschooler's Caregivers' Feeding Behaviour Scale scores as independent variables; Model 3 used demographic characteristics, as well as Chinese Preschooler's Caregivers' Feeding Behaviour Scale scores and Chinese Preschoolers' Eating Behaviour Questionnaire scores, as independent variables. (2) For classification variables, child's age, caregiver's level of education, and family monthly income were analysed based on '3–4 years old', 'junior high school or below' and 'under $750', respectively. (3) Data were analysed by logistic regression.

Abbreviations: BHRF, behaviour-restricted feeding; CI, confidence interval; EE, emotional eating; FR, food responsiveness; EXE, external eating; OR, odds ratio; RF, restricted feeding; SE, supervise eating; SR, satiety responsiveness; WEC, weight concerns.

The association between caregivers' feeding behaviour and weight in children

Childhood overweight/obesity has become a common concern in recent years. However, Branch *et al.*[21] found that concerns were rarely translated into healthier family meal characteristics or feeding behaviours. Maternal concerns alone may not be sufficient to motivate actions to reduce the risks of childhood obesity. In 2010, Webber *et al.*[20] used the CFQ to confirm the impact of maternal perceptions and concerns on the weight status of their children. Also, Ma *et al.*[37] developed a Young Child Feeding Questionnaire for 18-month-old infants and young children. The results obtained with use of this questionnaire showed that parental concerns about infant weight were positively correlated with BMI-for-age *z*-scores (β = 0.293, $p = 0.029$). Consistently, we found that caregivers' concerns about children's weight status during feeding led to increased BMI, suggesting that these feeding behaviours may increase risk for childhood obesity.

In 2012, Cheah *et al.*[38] conducted a CFQ survey on Chinese and Korean caregivers of children (3–8 years of age) in the USA. The results demonstrated the impact of feeding responsibility on a child's weight.[38] It was found that caregivers' feeding responsibility correlated negatively with overweight/obesity in children. The stronger the caregiver's sense of responsibility, the higher the chance that he/she would have healthy feeding behaviours, which may decrease a child's BMI and reduce the risk of obesity.

Associations among caregivers' feeding behaviour, children's eating behaviour and children's weight status

To organise various potentially overlapping constructs in the literature, Rodgers *et al.*[18] conducted a principal components analysis in a sample of 2-year-old children to clarify a set of core independent constructs representing maternal feeding styles. It was found that weight-based restriction, encouragement to eat, emotional feeding and restriction were positively correlated with the development of children's obesogenic eating behaviours, including food approach behaviours (such as good appetite and enjoyment of food), tendency to overeat and emotional eating. Moreover, Sleddens *et al.*[39] reported that the use of snacks as a reward may increase the number of external factors related to eating for the child and also may affect the child's eating behaviours by increasing exposure to unhealthy snacks, leading to overeating and obesity in children. Therefore, parents were advised not to use food to regulate children's behaviour or mood, as well as to encourage children's interest and curiosity in tasting different kinds of food. In the present study, the linear regression model showed a negative correlation between External Eating and BMI in children. The binary logistic regression also showed that children's Emotional Eating was negatively correlated with the occurrence of overweight/obesity, indicating that stimulate children's interest in tasting and eating different foods may promote the development of healthy eating behaviours in children, thereby reducing children's weight and decreasing the risk of obesity.

Stunkard *et al.*[40] used a three-factor dietary behaviour scale as a measurement tool and found that food response had a strong positive correlation with children's BMI. Wu *et al.*[41] used the Dutch version of the Adult Dietary Behavior Scale in 1171 middle school students and reached the same conclusion. Jansen *et al.*[13] performed a cross-sectional study using the CEBQ and CFQ and found that higher levels of parental restriction, children's food responsiveness and enjoyment of food were associated with higher BMI values, independent of measured confounders. Consistent with their findings, our results showed that children's responsiveness to food was positively correlated with excessive dietary intake, which may lead to an increase in BMI and a higher risk of obesity.

Viana *et al.*[42] and Sleddens *et al.*[43] used CEBQ to evaluate the dietary behaviour of a paediatric population (3–13 years of age) in Portugal and another paediatric population (6–7 years of age) in The Netherlands. The results showed a strong negative correlation between children's satiety response and their BMI. Jansen *et al.*[13] also confirmed that children's fussiness, children's satiety responsiveness, and parents' pressure to eat were negatively correlated with children's BMI. Our linear regression model did not incorporate Satiety Responsiveness. However, the binary logistic regression showed that children's Satiety Responsiveness had a significant negative correlation with overweight/obesity, indicating that children with greater satiety responsiveness had better capacity to regulate food consumption, which may prevent an excessive increase in BMI and reduce the incidence of overweight/obesity.

Previous evidence has shown that not only insufficient parental control,[44] but also parental over-control[45] contribute to overweight/obesity in children because children are likely tempted to overeat in the obesogenic environment. Poor parental restriction[46–48] and monitoring[46] of children's food intake were positively correlated with higher BMI values. Birch *et al.*[49] reported that caregivers' restriction of feeding may lead to unhealthy eating behaviours in children. Elford *et al.*[50] used an adapted version of the CFQ to explore the impact of other key care providers on the weight and eating habits of children. The results showed that a controlling maternal child-feeding style (e.g., restriction of certain food, the use of pressure to eat) was associated with fussy eating, overconsumption and abnormal weight. Conversely, a responsive child-feeding style, where children were encouraged to eat different kinds of food, encouraged to try new tastes and allowed to regulate their food intake, was associated with healthy eating styles and normal weight. Our results were not consistent with theirs. In the binary logistic regression model, Restriction Feeding was negatively correlated with the occurrence of overweight/obesity, indicating that a child had healthy eating behaviours when a caregiver restricted his/her food consumption, and thus the risk of overweight/obesity was decreased.

We did not identify a relationship among caregiver feeding behaviours (e.g., Content-Restricted Feeding, Forced Feeding, Supervised Eating), children's eating behaviours (e.g., Eating Habits, Initiative Eating) and children's BMI or overweight/obesity status. The influencing factors are complex because dietary culture and feeding habits vary among regions, ethnicities and family social environments. Another source of complexity is the diversity of caregivers' feeding practices and children's eating behaviours.

Limitations

The present study had some limitations. First, the study participants may not have been representative of the entire population of preschool children in China because we only recruited subjects from Jinan and Xi'an City. Second, the sample size was small. Third, the present study was limited by its cross-sectional design. Longitudinal studies are necessary to determine the direction of causality. Also, the information pertaining to children's eating behaviours was collected based on the subjective opinions of caregivers, which may have been confounded by reporting bias. Future investigations on other potential confounding factors will be needed.

CONCLUSIONS

In summary, the present study comprehensively evaluates the relationships among demographic characteristics,

caregivers' feeding behaviour, children's eating behaviour and children's weight status using regression analyses. Our results show that caregivers' feeding behaviours and children's eating behaviours are associated with children's weight status and the occurrence of overweight/obesity in China, suggesting that the prevention of overweight/obesity among children may require behavioural changes on the parts of both children and their caregivers. These findings provide reference information for the development of healthy feeding habits and the optimisation of prevention and intervention strategies for the management of childhood obesity.

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CONFLICT OF INTERESTS

The authors have no conflicts of interest.

AUTHOR CONTRIBUTIONS

LS and JX conceived the study and led the writing of the manuscript. All authors designed the study and reviewed versions of the protocol. JY, TZ, YZ and YW organised and supervised the data collection phase of the study. JY, TZ, YZ and XY conducted the data analysis and also participated in the writing of the manuscript. LS, XJ and YZ analysed 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 submitted for publication.

ETHICAL STATEMENT

This study was approved by the Research Ethics Committee of the Fourth Military Medical University (November 16, 2018) and all procedures were performed in accordance with the relevant regulations and guidelines. All caregivers recruited provided written informed consent prior to the collection of any information.

TRANSPARENCY DECLARATION

The lead author affirms that this manuscript is an honest, accurate and transparent account of the study being reported. The reporting of this work is compliant with STROBE guidelines. The lead author affirms that no important aspects of the study have been omitted and that any discrepancies from the study as planned have been explained.

PEER REVIEW

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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