

Relationships of Family food environment with food and nutrition literacy in Chinese school-age children

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Abstract

Background: Eating behavior is influenced by multiple factors and understanding the interplay of these factors is necessary to promote children's healthy food choice. This study investigated the relations of family food environment (FFE) with food and nutrition literacy (FNL) in Chinese school-age children.

Methods: A total of 605 children aged 7-13 years from Grade 1 to 5, and their caregivers participated in the cross-sectional study in Beijing of China during April 2019. The FFE was assessed by the validated *Family Food Environment Questionnaire for Chinese School-age Children* (FFEQ-SC). For the children of Grade 3 to 5 (n=260), the FNL, including cognitive and skill domains, was assessed by *Food and Nutrition Literacy Questionnaire for Chinese School-age Children* (FNLQ-SC). Both FFEQ-SC and FNLQ-SC were developed firstly for Chinese school-age children who had good reliability. The anthropometric data (height and weight) was derived from local health information management system for primary schools.

Results: Overall, 68.9% of the children's families had high level of FFE. The total FNL score of 260 children at Grade 3-5 was 63.2 ± 10.3 . Comparison of children's FNL scores among different levels of FFE showed the children with higher level of FFE, especially higher level of caregiver's educational degree and FNL, were more likely to have higher FNL scores ($P < 0.05$). The multivariate analysis showed the children's total FNL score was significantly related with family caregiver ($\beta = -0.123$, $P = 0.04$) and caregiver's nutritional literacy ($\beta = 0.210$, $P = 0.002$). Furthermore, the children with higher level of caregiver's nutritional knowledge were less likely to be overweighted or obese (OR=0.043, $P = 0.04$).

Conclusions: Family food environment, especially caregivers' FNL, was related with children's FNL, even the risk of overweight. These findings highlight the importance of targeting nutritional knowledge of family caregivers to facilitate the children's FNL to maintain good health.

Background

The food choices and dietary quality in childhood, which produce an effect on the lifelong risk of nutrition-related diseases [1, 2], have worldwide remained in a poor level. The results for the students aged 13 to 15 of the Global School-Based Student Health Survey in 2019 presented that among all countries, roughly a half observed a percentage of 10%-30% students that did not eat any fruit and a quarter reported the same percentage with zero intake of vegetables; nearly 70% identified at least 50% students that ate fast food on a weekly basis; and all found 20% of their students consumed carbonated soft drinks at least once a day [3]. Recent studies suggested that in developed countries, even with a slight decrease from 2000, unhealthy eating behavior in childhood may have reached plateau, while in many developing and transition countries as China, this issue has become far more complex and intractable [4]. Latent class analysis of the China Health and Nutrition Survey data characterized four types of food preferences in 697 adolescents aged 12 to 17, namely, varied diet (37.09%), avoiding vegetables (19.69%), low appetite (7.56%), and healthy diet (35.66%) [5]. An investigation of 507 primary students (Grade 5) in Beijing of China in 2018 found that vegetables, fruits and dairy respectively accounted for 80.3%, 67.8% and 60.0% of the daily dietary intake, and furthermore 12.7%-22.1% children consumed sugar-sweetened beverages and sweets more than 4 days a week [6].

Following an ecological model, food choices and eating behavior depend on the interaction of diverse environmental and individual factors, such as genetics, sociodemographic characteristics, and nutrition-related knowledge and skills[7]. At individual level, food and nutrition literacy (FNL) generally refers to the combination of capacities to obtain, process and understand nutrition information, and skills to arrange nutritious diet and maintain health, which provides one explanation to the poor nutrition and bad behaviors among children and adolescents [8]. Therefore, it is becoming increasingly difficult to ignore FNL. A system review compiled 13 nutrition literacy and/or food literacy instruments in adults[9], and 29 health literacy instruments for children and adolescents until 2018 in different countries[10], but the assessment of children and adolescents' FNL still parks. Previous studies had developed a few tools, such as Food and Nutrition Literacy questionnaire in elementary school children in Tehran of Iran[11], a 37-item and 5-dimensional food literacy instrument for school children in Denmark[12], and Tool for Food Literacy Assessment in Children (TFLAC) for American children[13]. Considering that FNL varies with both nationalities and ages, to our best knowledge, before us there existed no standardized FNL assessment for Chinese children, and we have developed a food and nutrition literacy questionnaire for Chinese school-age children[14].

A systematic review suggested that food literacy may play a vital role in shaping adolescent's eating behavior and food choice, and additionally food skills and behaviors learned during this time are sustained in later stages of life[15]. A cross-sectional study

conducted in 803 primary school students in Tehran of Iran found a significant association between low FNL and high odds of low dietary diversity score, as well as low nutrient adequacy of protein, calcium, and vitamin B₃, B₆, B₉[16]. FNL promotion is crucial for food choice and dietary pattern maintenance, thus it's necessary to explore related factors and develop corresponding strategies and interventions [17].

Both FNL and eating behaviors are highly complex and influenced by multiple factors across various contexts, which have been given the function as social and physical environment [18, 19]. Families and peers partly consist of the children's ecological niche, and they can get affected by community, society, media, and food offering[20], which are then defined as environmental factors. In view that most of children's eating behaviors occur at and around home, family food environment (FFE) may exert impact on children's FNL and eating behaviors [21]. Young children depend on their families to support wellbeing and promote positive development, including FNL and eating behaviors. The FFE is the most fundamental context in which children's eating behaviors are socialized and food knowledge and preferences are formed. A systematic review indicated household food availability, nutritional knowledge of families or caregivers, and family income, which were consistently and positively associated with children's healthy food consumption, to be FFE [22]. Given above, FFE is multidimensional, including family food availability, family eating rules and feeding patterns, caregiver's FNL and so on, and each dimension can influence children's food choice. A Cochrane living systematic review assessed the effectiveness of 78 eligible intervention trials till August 2019, the results of which showed that parents' child-feeding practice may lead to slight increase in fruit and vegetable consumption in children, with very low-quality evidence, and suggested more rigorous methods to be adopted in future researches[23].

Individual FNL and contextual food environment are both important to influence children's eating behaviors; but the two factors' interaction remains unclear. It has been hypothesized that the food environment, especially the caregivers' nutritional knowledge and skills, may help children develop FNL. Therefore, this study investigated the relationship of family food environment (FFE) with food and nutrition literacy (FNL) in Chinese school-age children, and hoped to provide evidence for further intervention.

Methods

The family food environment questionnaire for Chinese school-age children

The study firstly developed and validated the Family Food Environment Questionnaire for Chinese School-age Children (FFEQ-SC). The conceptual framework and dimensions of FFEQ-SC were preliminarily constructed based on literature review and evaluated by food and nutrition experts in the study steering group.

The framework for the Analysis Grid for Elements Linked to Obesity (ANGELO) process was first developed as a practical tool to categorize and scan the environment for potential environmental barriers to healthy eating and physical activities [24]. The basic framework was a 2x4 grid which divided obesogenic environments into two sizes of environment – micro and macro, and four types of environment – physical, economic, policy and sociocultural. Referring to ANGELO framework and other assessment instruments, the FFEQ-SC was designed with six dimensions: 1) Family sociodemographic characteristics, including family structure (member number), family economic status, caregivers and their educational level and so on. The family economic status was assessed using adjusted "The Family Affluence Scale (FAS)", which was a six-item scale used in Health Behavior in School-aged Children (HBSC), a WHO collaborative cross-national study[20]. Considering the Chinese family situation, three items were remained, namely "How many cars, van or truck do your family have?"; "Does your child have its own bedroom?"; "How many times did your family travel for a holiday/vacation last year?". 2) Caregiver's food and nutrition literacy, including nutritional knowledge and skills (food and nutrients, dietary guideline, food labeling and food portion), modeling and encouragement practices, discussing nutrition information with children, and so on. 3) Family feeding patterns, including permission (I permit my child to eat what he/she wants.), restriction (I have to be sure that my child does not eat too many foods high in sugar, fat and salt.), enforcement patterns (If my child says "I am not hungry" I try to get him/her to eat anyway.) and so on. 4) Family eating rules, including focusing on dinner (No meals while watching TV/DVDs), food limitation (Limited sweet or fried snacks.) and food preparation (My child must help prepare food and do the dishes). 5) Family meal practices, including location, length, frequency and members present of family meals. 6) Family food availability, including healthy foods (fruits and vegetables, dairy products and whole grain) and unhealthy foods high in sugar, fat and salt.

Secondly, a cross-sectional survey was conducted in 599 Chinese school-age (7-13 years) children's parents, to analyze the reliability and validity of FFEQ-SC. The preliminary questionnaire had 54 items. Finally, 47 items were determined by the exclusion criteria as item discrimination less than 0.1, coefficient of difficulty more than 0.15 and less than 0.85, factor loads less than 0.4, and factor

loading coefficients were similar in 2 or more than 2 factors. The overall FFEQ-SC questionnaire had acceptable internal consistency (Cronbach's α = 0.78, split-half reliability = 0.84). The exploratory factor analysis extracted 15 factors which were included in the conceptual framework, and cumulative contribution of variance accounted to 62.33%. The Pearson correlation coefficients between dimensions and total questionnaire were from 0.33 to 0.76. The results of construct validity were χ^2/df = 1.97, goodness of fit index (GFI) = 0.88, adjusted goodness of fit (AGFI) = 0.85, normed fit index (NFI) = 0.86, incremental fit index (IFI) = 0.92, comparative fit index (CFI) = 0.92, root mean square residual (RMR) = 0.03, and root mean square error of approximation (RMSEA) = 0.04 ($P > 0.05$). The results showed the FFEQ-SC had good reliability, and it could potentially be a useful instrument to assess FFE for Chinese school-age children. The FFEQ-SC was shown at Additional file 1.

The food and nutrition literacy questionnaire for Chinese school-age children

Literatures retrieval showed there were some FNL assessment instruments developed for adult population in different contexts. In comparison the assessment instrument for children was rare, and existing instruments were designed in Iran, Danish and American contexts, which were not suitable to be adjusted for use in Chinese children as huge differences of dietary patterns exist between China and these countries. Considering the difference of cognition and eating behaviors, the FNL questionnaire should be different for children in different ages. Based on these, we developed and validated a new FNL assessment questionnaire for Chinese school-age children, the Food and Nutrition Literacy Questionnaire for Chinese School-age Children (FNLQ-SC).

The conceptual framework and dimensions of FNLQ-SC were preliminarily constructed based on literature review and experts interview, within the cognitive level and dietary behavior problems in school-age children taken into consideration. In this study FNL is defined as "collection of inter-related knowledge, skills and behaviors required to plan, manage, select, prepare, and eat foods to meet needs, and determine food intake". A two-stage electronically distributed Delphi consultation study was conducted to determine the dimension and core components of FNLQ-SC. Finally, 19 core components of FNLQ-SC were determined, including five dimensions of food and nutrition-related knowledge and understanding (cognitive domain), the ability of access, selection, preparing of food and healthy eating (skill domain), as well as three levels of functional, interactive and critical literacy. The final questionnaire set 50 questions.

Secondly, a cross-sectional survey was conducted in 2452 Chinese children aged 10-15 years, to analyze the reliability and validity of FNLQ-SC. The results showed the overall FNLQ-SC questionnaire had acceptable internal consistency (Cronbach's α = 0.698). Regarding the five dimensions (knowledge and understanding, access and planning of food, selecting food, preparing food, eating), Cronbach's α coefficient was 0.452, 0.300, 0.244, 0.148, and 0.436, respectively. The Kaiser-Meyer-Olkin (KMO) test showed sampling adequacy (KMO = 0.738), and Bartlett's test confirmed factor analysis was appropriate ($P < 0.001$). The exploratory factor analysis (EFA) of skill components extracted 5 factors (selecting and eating, access and preparation, food label and measurement, picky eating, snacks) with eigenvalue more than 1, and cumulative contribution of variance accounted to 50.60%. The commonality was more than 0.20 for all components. The Pearson correlation coefficients among different dimensions ranged 0.152-0.400, and correlation coefficients between dimensions and total questionnaire were from 0.370 to 0.877, especially the dimension of knowledge and understanding, selecting food, and eating, whose coefficients were more than 0.6, showed strong correlation with the total questionnaire. The results showed the FNLQ-SC had acceptable reliability, and it could potentially be a useful instrument for assessing FNL for Chinese school-age children. The FNLQ-SC was shown at Additional file 2.

Participants and data collection

A cross-sectional survey was conducted in a primary school in Beijing of China using convenient sampling during April 2019. The investigators explained the study protocol to all students from Grade 1 to 5 (aged 7-13 years) and their parents or other caregivers at parent-teacher meeting. Finally, written informed consent was obtained from 605 children and their guardians, with a response rate of 99.2%.

For all participant children ($n=605$), the FFE was assessed by developed self-administered FFEQ-SC, which was filled out by children's caregiver.

Considering the differences of cognition, reading and writing literacy between junior and senior students, the FNL should be assessed by different instruments. Based on these, just for the senior children of Grade 3 to 5 ($n=260$), the FNL was assessed by self-administered FFEQ-SC, which was developed and validated for students of Grade 3-9, not for junior primary students (Grade 1-2).

The children's anthropometric data (height, weight) were derived from "Beijing health information management for primary and secondary schools", which was measured in April 2019. The permission of school, the children and their parents was obtained under the help of school administrative staff and sensitive and irrelevant information was filtrated. The children's BMI (kg/m²) was calculated and defined according to Chinese standards of "Screening for overweight and obesity among school-age children and adolescents (WS/T 586-2018)" and "Screening standard for malnutrition of school-age children and adolescents (WS/T 456-2014)".

The study protocol was approved by the Peking University Institutional Review Board (Beijing, China), and conducted according to the Declaration of Helsinki and ethical guidelines. The privacy of participant students and the confidentiality of their personal information would be protected.

Statistical analysis

In the FFEQ-SC, the relations of some items (such as family structure, children's caregiver) with children's FNL, eating behaviors and even health outcome remained bidirectional and inconsistent, which could not be scored. Besides these items, the total score of FFEQ-SC was 94, including family sociodemographic characteristics (18), caregiver's FNL (20), family feeding patterns (14), family eating rules (18), family meal practices (8), and family food availability (16). Considering the scores were positively related with better/healthier performance theoretically, so the six dimensions were reclassified into two levels, high/good/healthy ($\geq P60$ of total score) and low/poor/unhealthy ($< P60$ of total score). It was noteworthy that higher score of family feeding patterns was associated with more freedom of children's food choice, and then different feeding patterns were defined as permission ($\geq P60$ of total score), restriction ($P40-P60$) and enforcement ($< P40$) patterns.

The total scores of FNLQ-SC were 92 in Grade 3-4 and 98 in Grade 5 respectively, which were converted in a centesimal measure for further statistical analysis. And the dimensions of knowledge and understanding, access to and planning for food, selecting food, preparing food and eating included 7, 2, 10 (8 at grade 3-4), 5, 25 (22 at grade 3-4) questions respectively. A receiver operating characteristic (ROC) analysis was always used to determine the optimal FNL cut-off score [14], which compared the performance of the FNL score against the 'gold standard' measure of overall dietary quality like healthy eating index (HEI), to identify the cut-off point of FNL scale. Unfortunately, the dietary intake was not investigated in our study, so the cut points of FNL could not be identified, and the FNL score was analyzed as continuous variable.

The relations of FFE with FNL of children were analyzed to compare the FNL difference among different FFE groups by t-test, *F* test and least significant difference (LSD) methods. Also correlation coefficient was calculated between different dimensions of FFE scores and FNL scores. Multivariate linear regression analysis was employed to explore the related factors of FNL and overweight risk in children. The statistical significance is $P < 0.05$.

Results

Characteristics of the participant children and their family food environment

Among all 605 children of Grade 1-5, there were 303 (50.1%) boys and 302 (49.9%) girls, aged 7-13 years. And 54.7% of the children came from "only child" families. Overall, 68.9% of children's families had higher level of FFE. Most of the family caregivers were their mother (71.4%) or father (27.1%). More than half (59.5%) of the caregiver's received junior college or higher education, and among those 69.3% had high level of FNL. More families restricted (61.3%) or enforced (20.2%) their children to eat or not to eat certain foods, compared with permission feeding pattern (18.5%). Most of the families had eating rules (65.3%) and good meal practices (68.9%). And 78.2% of the families supplied their children with more healthy foods than unhealthy foods.

Among 260 children in subgroup at Grade 3-5, the percentage of Grade 3, 4, 5 were 22.3%, 35.0% and 42.7%, respectively, aged from 9 to 13 years. The prevalence of overweight and obesity was 16.9% and 20.8% respectively. Nearly half of children (48.8%) were "only child". Overall, 61.5% of children's families had high level of FFE. Most of the family caregivers were their mother (69.2%) or father (28.8%), and 68.8% of the caregivers had high level of FNL. More families adopt restriction (61.5%) and enforcement (24.2%) feeding patterns. Most of the families had eating rules (61.5%) and good meal practices (65.0%). And 69.6% of the families supplied their children with more healthy foods than unhealthy foods. The characteristics of the children and their families are shown in Table 1.

Table 1. Characteristics of the participant children and their family food environment n (%)

Characteristics	Total (n=605)	Subgroup (n=260)
Gender		
Boys	303 (50.1)	125 (48.1)
Girls	302 (49.9)	135 (51.9)
Age (years)		
7-8	304 (50.2)	—
9-10	169 (27.9)	133 (51.2)
11-13	132 (21.8)	127 (48.8)
Grade		
Junior (1-2)	308 (50.9)	—
Senior (3-5)	297 (49.1)	260 (100.0)
Weight status (BMI)		
Wasted	31 (5.1)	11 (4.2)
Normal	331 (54.7)	151 (58.1)
Overweight	90 (14.9)	44 (16.9)
Obesity	153 (25.3)	54 (20.8)
Only child		
Yes	331 (54.7)	127 (48.8)
No	274 (45.3)	133 (51.2)
Family size (member number)		
≤3	194 (32.1)	79 (30.4)
4	179 (29.6)	98 (37.7)
≥5	232 (38.3)	83 (31.9)
Family economic status		
Poor (≤2)	72 (11.9)	25 (9.6)
Medium (3-5)	325 (53.7)	138 (53.1)
Affluent (6-7)	208 (34.4)	97 (37.3)
Caregiver		
Mother	432 (71.4)	180 (69.2)
Father	164 (27.1)	75 (28.8)
Others	9 (1.5)	5 (1.9)
Caregiver's educational level		
≤High school	245 (40.5)	138 (53.1)
≥Junior college	360 (59.5)	122 (46.9)
Caregiver's food and nutrition literacy		
High (≥12.0)	419 (69.3)	179 (68.8)
Low (<12.0)	186 (30.7)	81(31.2)
Family feeding patterns		
Permission (≥8.4)	112 (18.5)	37 (14.2)
Restriction (5.6-8.4)	371 (61.3)	160 (61.5)
Enforcement (<5.6)	122 (20.2)	63 (24.2)
Family eating rules		
High (≥10.8)	395 (65.3)	160 (61.5)
Low (<10.8)	210 (34.7)	100 (38.5)
Family meal practices		
Good (≥4.8)	417 (68.9)	169 (65.0)
Poor (< 4.8)	188 (31.1)	91 (35.0)
Family food Availability		
Healthy(≥9.6)	473 (78.2)	181 (69.6)
Unhealthy (<9.6)	132 (21.8)	79 (30.4)
Total family food environment score		
High (≥56.4)	417 (68.9)	160 (61.5)
Low (<56.4)	188 (31.1)	100 (38.5)

The family food environment was divided into high/good/healthy ($\geq P60$ of total score) and low/poor/unhealthy ($<P60$ of total score). The family feeding patterns were classified into three categories: permission ($\geq P60$ of total score), restriction ($P40-P60$) and enforcement ($<P40$) patterns.

Family sociodemographic distribution of food and nutrition literacy in children

The total FNL score of 260 children in Grade 3-5 was 63.2 ± 10.3 , ranged from 30.4 to 89.9 (centesimal measure). As shown in Table 2, the girls had higher FNL score than boys, especially the ability to select food ($P=0.04$). The FNLQ-SC score increased by grade, and the abilities of accessing planning and selecting food in the 5th grader were much higher than those of the 3rd grader ($P=0.001$).

Table 2. Characteristics comparison of food and nutrition literacy in children (mean \pm SD)

Sociodemographic characteristics	n	Knowledge and understanding	Access and planning of food	Selecting food	Preparing food	Eating	Total FNL scores
Total	260	11.1±2.7	2.8±0.8	12.3±3.1	6.2±1.6	30.8±5.6	63.2±10.3
Gender							
Boys	125	10.8±2.7	2.8±0.8	11.9±3.1 ^a	6.4±1.6	30.4±5.6	62.3±10.4
Girls	135	11.3±2.6	2.9±0.8	12.7±3.1 ^b	6.1±1.6	31.2±5.7	64.1±10.2
<i>P</i>		0.13	0.23	0.04*	0.09	0.27	0.15
Grade							
3	58	10.5±2.8	2.5±0.9 ^a	11.2±2.9 ^a	6.1±1.5	30.4±6.4	60.6±11.2
4	91	11.3±2.6	3.0±0.8 ^b	12.4±2.6	6.3±1.6	31.4±5.3	64.4± 8.4
5	111	11.3±2.6	2.9±0.7 ^b	12.8±3.4 ^b	6.2±1.7	30.6±6.4	63.7±11.1
<i>P</i>		0.17	<0.001*	0.006*	0.74	0.45	0.08
Only child							
Yes	127	11.3±2.7	2.9±0.7	12.7±2.9 ^a	6.3±1.7	31.6±5.3 ^a	64.9±10.1 ^a
No	133	10.8±2.6	2.8±0.8	11.9±3.2 ^b	6.1±1.7	30.1±5.9 ^b	61.6±10.3 ^b
<i>P</i>		0.11	0.14	0.03*	0.35	0.03*	0.01*
Family size (number of family members)							
≤3	79	11.2±2.7	2.9±0.8	12.6±3.0	6.3±1.7	31.5±5.9	64.5±10.4
4	98	11.0±2.7	2.7±0.8	12.1±3.1	6.2±1.6	30.4±5.6	62.4±10.4
≥5	83	11.0±2.7	2.9±0.7	12.2±3.2	6.2±1.6	30.8±5.5	63.0±10.2
<i>P</i>		0.86	0.28	0.51	0.77	0.44	0.38
Family economic status							
Poor (≤2)	25	11.3±3.0	2.9±0.7	11.8±2.7	6.2±1.5	28.4±5.0	60.6± 9.5
Medium (3-5)	138	11.0±2.7	2.8±0.8	12.3±3.3	6.0±1.5	31.0±5.3	63.1±10.3
Affluent (6-7)	97	11.0±2.6	2.9±0.7	11.4±2.9	6.5±1.8	31.3±6.4	64.2±10.6
<i>P</i>		0.91	0.54	0.69	0.08	0.07	0.29
Caregiver							
Mother	180	11.0±2.7	2.8±0.8	12.1±2.9	6.2±1.6	30.4±5.7 ^a	62.4±10.3 ^a
Father	75	11.3±2.6	2.9±0.8	12.8±3.4	6.3±1.6	32.2±5.2 ^b	65.4± 9.9 ^b
<i>P</i>		0.42	0.34	0.10	0.50	0.02*	0.03*
Caregiver's educational level							
≤High school	138	10.3±2.7	2.8±0.8	11.8±3.3 ^a	6.0±1.7 ^a	30.0±6.0 ^a	61.4±10.7 ^a
≥Junior college	122	11.3±2.6	2.9±0.8	12.8±2.8 ^b	6.5±1.6 ^b	31.8±5.1 ^b	65.3± 9.6 ^b
<i>P</i>		0.13	0.64	0.008*	0.03*	0.009*	0.003*
Total family food environment							
High (≥56.4)	160	11.5±2.6	2.9±0.7	12.7±3.0	6.4±1.6	31.9±5.1	65.4± 10.0
Low (<56.4)	100	10.3±2.6	2.7±0.9	11.7±3.1	6.0±1.7	29.1±5.1	59.7± 11.7
<i>P</i>		<0.001*	0.02*	0.01*	0.05*	<0.001*	<0.001*
Caregiver's food and nutrition literacy							
High (≥12.0)	179	11.5±2.7	2.9±0.7	12.7±3.1	6.4±1.6	31.5±5.8	65.0±10.3
Low (<12.0)	81	10.1±2.4	2.7±0.8	11.4±2.8	5.9±1.6	29.4±5.1	59.4± 9.4
<i>P</i>		<0.001*	0.01*	0.001*	0.03*	0.007*	<0.001*
Family feeding patterns							
Permission (≥8.4)	37	10.7±3.0	2.8±0.9	12.1±3.0	6.5±1.6	31.5±5.2	63.6± 9.8
Restriction(5.6-8.4)	160	11.2±2.6	2.8±0.8	12.4±3.0	6.1±1.6	30.8±5.8	63.2±10.2
Enforcement(<5.6)	63	11.0±2.6	2.9±0.7	12.1±3.3	6.4±1.7	30.6±5.6	63.0±11.0
<i>P</i>		0.66	0.70	0.75	0.24	0.73	0.96
Family eating rules							
High (≥10.8)	160	11.4±2.7	2.9±0.7	12.6±3.0	6.2±1.6	31.7±5.8	64.8±10.3
Low (<10.8)	100	10.5±2.6	2.7±0.8	11.8±3.2	6.3±1.6	29.5±5.1	60.7± 9.8
<i>P</i>		0.007*	0.003*	0.05	0.86	0.002*	0.002*
Family meal practices							
Good (≥4.8)	169	10.9±2.8	2.8±0.8	12.2±3.1	6.1±1.5	30.7±5.6	62.7±10.3
Poor (< 4.8)	91	11.4±2.5	2.8±0.8	12.4±3.0	6.4±1.8	31.1±5.7	64.2±10.4
<i>P</i>		0.09	0.90	0.60	0.25	0.57	0.28
Family food availability							
Healthy(≥9.6)	181	11.3±2.6	2.9±0.7	12.4±3.2	6.3±1.6	31.2±5.6	64.0±10.5
Unhealthy (<9.6)	79	10.6±2.8	2.8±0.9	6.3±1.6	6.0±1.8	30.1±5.6	61.4± 9.8
<i>P</i>		0.04*	0.46	0.44	0.13	0.14	0.06

* $P < 0.05$, Statistical test used t/F -text. Different superscript characters (a, b) mean statistical difference among groups ($P \leq 0.05$).

Not only above individual characteristics, but also the family sociodemographic characteristics, including the number of children in the family, the caregiver and their educational level, were significantly related with children's FNL. The "only child" had higher FNL score (64.9±10.1 vs 61.6±10.3, $P=0.01$), especially the ability of selecting and eating food ($P < 0.05$). Furthermore, the children cared by their father dominantly had higher total FNL compared with those cared by mother (65.4±9.9 vs 62.4±10.3, $P=0.01$). Also the caregiver's educational level was positively associated with children's FNL ($P=0.003$), especially in dimensions of selecting, preparing and eating food ($P < 0.05$), as shown in Table 2.

Relationship of family physical and sociocultural food environment with food and nutrition literacy in children

As shown in Table 2, comparison of the FNL scores in children between two FFE levels showed the children with high level of FFE, especially high level of caregiver's FNL, had significant higher FNL scores, including total score and all domains of cognitive and skills ($P < 0.05$). Furthermore, the children with high level of family eating rules were more likely to have higher FNL scores, especially in dimensions of knowledge and understanding, the ability of accessing and planning of food, and eating ($P < 0.05$). If the family supplied

the children with more healthy foods than unhealthy foods, the children had much higher score of food and nutrition related knowledge and understanding ($P<0.05$).

Further correlation analysis between FFE score and children's FNL score showed similar results, the scores of total FFE, dimensions of family sociodemographic characteristics, caregiver's FNL, family eating rules, and family food availability were positively related with children's FNL score, as shown in Table 3. The total FFE and caregiver's FNL scores were positively related with children's FNL scores of different domains and dimensions ($P<0.05$). The "family eating rules" score was positively related with children's FNL scores of cognitive and total skill domains ($P<0.05$). The "family food availability" score was positively related with children's FNL scores of "access and planning of food" dimension ($P<0.05$). The higher "family sociodemographic characteristics" score was significantly related with higher "preparing food", "eating" scores of children ($P<0.05$). The dimensions of "family feeding patterns" and "family meal practices" were not related with children's FNL score ($P>0.05$).

Table 3. Correlation coefficient between family food environment (FFE) score and food and nutrition literacy (FNL) score in children (n=260)

Family food environment scores	Total score of FNL		Cognitive domain Knowledge and Understanding		Skill domain									
					Total		Access and planning of food		Selecting food		Preparing food		Eating	
	R	P	r	P	r	P	r	P	r	P	r	P	r	P
Total score of FFE	0.265	<0.001*	0.221	<0.001*	0.249	<0.001*	0.184	0.003*	0.189	0.002*	0.084	0.18	0.228	<0.001*
Family sociodemographic characteristics	0.139	0.03*	0.026	0.67	0.158	0.01*	0.023	0.71	0.082	0.19	0.163	0.009*	0.147	0.02*
Caregiver's FNL	0.287	<0.001*	0.301	<0.001*	0.250	<0.001*	0.155	0.012*	0.225	<0.001*	0.067	0.29	0.219	<0.001*
Family feeding patterns	0.029	0.64	-0.001	0.99	0.035	0.58	-0.022	0.72	0.032	0.61	-0.011	0.86	0.042	0.30
Family eating rules	0.144	0.02*	0.162	0.009*	0.122	0.05*	0.164	0.008*	0.102	0.10	-0.019	0.76	0.114	0.07
Family meal practices	0.019	0.76	-0.060	0.34	0.042	0.50	0.031	0.62	0.064	0.30	-0.038	0.54	0.036	0.57
Family food availability	0.122	0.05*	0.109	0.08	0.113	0.07	0.124	0.05*	0.036	0.56	0.105	0.09	0.105	0.09

* $P<0.05$, Statistical test used correlation analysis.

Multivariable analysis

To analyze the relations of FFE with children's FNL generally, the multivariate linear regression analysis showed that the children's FNL score was associated with caregivers and their educational level and FNL score. The children cared dominantly by their father, had higher total and skill domain FNL scores ($P=0.04$), compared with those cared by the mother. The children's total FNL ($\beta=0.210$, $P=0.002$) cognitive ($\beta=0.263$, $P<0.001$) and skill ($\beta=0.170$, $P=0.01$) domain scores were positively related with the caregivers' FNL, and the cognitive domain score was also positively related with the caregivers' educational level ($\beta=0.139$, $P=0.04$). The details were showed in Table 4.

Table 4. Multivariable analysis of food and nutrition literacy (FNL) in children (n=260)

Variables	Total FNL			Cognitive domain of FNL			Skill domain of FNL		
	β	95%CI	P	β	95%CI	P	β	95%CI	P
Gender	-0.083	(-4.144, 0.732)	0.17	-0.098	(-1.162, 0.117)	0.11	-0.069	(-3.232, 0.864)	0.26
Grade	0.083	(-0.498, 2.683)	0.18	0.078	(-0.152, 0.683)	0.21	0.075	(-0.509, 2.164)	0.22
Only child	0.065	(-1.314, 3.982)	0.32	0.046	(-0.452, 0.938)	0.49	0.064	(-1.134, 3.316)	0.34
Family economic status	0.013	(-1.811, 2.228)	0.84	-0.103	(-0.965, 0.094)	0.11	0.047	(-1.052, 2.340)	0.46
Caregiver	-0.123	(-5.442, -0.105)	0.04*	-0.021	(-0.820, 0.580)	0.74	-0.141	(-4.896, -0.412)	0.02*
Caregiver's educational level	0.131	(-0.037, 5.403)	0.05	0.055	(-0.419, 1.008)	0.42	0.139	(0.103, 4.673)	0.04*
Caregiver's FNL score	0.210	(0.289, 1.211)	0.002*	0.263	(0.122, 0.364)	<0.001*	0.170	(0.119, 0.894)	0.01*
Family feeding patterns score	-0.001	(-0.854, 0.845)	0.99	-0.026	(-0.268, 0.177)	0.69	0.007	(-0.673, 0.755)	0.91
Family eating rules score	0.057	(-0.207, 0.514)	0.40	0.096	(-0.028, 0.162)	0.16	0.039	(-0.216, 0.389)	0.57
Family eating practices score	0.015	(-0.724, 0.924)	0.81	-0.075	(-0.350, 0.082)	0.22	0.041	(-0.458, 0.927)	0.51
Family food availability score	0.025	(-0.520, 0.762)	0.71	-0.005	(-0.174, 0.162)	0.94	0.031	(-0.411, 0.666)	0.64

* $P<0.05$. Statistical test used multiple linear regression analysis.

In the subgroup of Grade 3-5, 37.7% of children were overweighted or obese. To further analyze the relations of FFE with overweight risk in children, the multivariate logistic regression analysis showed the children with higher level of caregiver's FNL were less likely to be overweight or obesity (OR=0.043, 95%CI: 0.292-0.981, $P=0.04$), as shown in Table 5.

Table 5. Relations of family food environment and food and nutrition literacy (FNL) with overweight risk in children (n=260)

Variables	B	SE	χ^2	P	OR	95%CI
Gender						
Girl	Reference					
Boy	0.638	0.278	5.266	0.02*	1.892	(1.098, 3.262)
Grade						
3	Reference					
4	-0.167	0.371	0.203	0.65	0.846	(0.409, 1.750)
5	-0.416	0.364	1.307	0.25	0.660	(0.323, 1.346)
Only child						
No	Reference					
Yes	-0.518	0.292	3.135	0.08	0.596	(0.336, 1.057)
Children's FNL						
Low (<60)	Reference					
High (≥ 60)	0.110	0.307	0.128	0.72	1.116	(0.611, 2.039)
Caregiver						
Father	Reference					
Mother	0.145	0.310	0.219	0.64	1.156	(0.629, 2.125)
Family economic status						
Poor	Reference					
Medium	0.670	0.511	1.714	0.19	1.953	(0.717, 5.322)
Affluent	0.307	0.533	0.333	0.56	1.360	(0.479, 3.863)
Caregiver's educational level						
\leq High school	Reference					
\geq Junior college	0.333	0.310	1.154	0.28	1.395	(0.760, 2.560)
Caregiver's FNL						
Low (<12.0)	Reference					
High (≥ 12.0)	-0.626	0.309	4.088	0.04*	0.535	(0.292, 0.981)
Family feeding patterns						
Enforcement (<5.6)	Reference					
Restriction (5.6-8.4)	0.704	0.467	2.271	0.13	2.022	(0.809, 5.051)
Permission (≥ 8.4)	0.212	0.342	0.383	0.54	1.236	(0.632, 2.416)
Family eating rules						
Low (<10.8)	Reference					
High (≥ 10.8)	0.088	0.310	0.082	0.78	1.093	(0.595, 2.005)
Family meal practices						
Poor (< 4.8)	Reference					
Good (≥ 4.8)	-0.154	0.289	0.284	0.59	0.857	(0.486, 1.511)
Family food Availability						
Unhealthy (<9.6)	Reference					
Healthy (≥ 9.6)	-0.168	0.315	0.284	0.59	0.845	(0.456, 1.568)

* $P < 0.05$, Statistical test used logistic regression.

Discussion

The interaction of individual characteristics and contextual environmental factors has been thought of as a determinant in children's food choice and dietary quality[7]. Using self-administered FFEQ-SC, this study examined the relationship between family food environment (FFE) with food and nutrition literacy (FNL) in Chinese school-age children, and reported a significant relation of caregivers and their educational level and nutrition literacy with the children's FNL and overweight risk.

FFE is important as it's where most of children's eating behaviors occur, and several models have been proposed to conceptualize it[7, 20, 25]. These models' constructs overlapped and lay the foundation of our family food environment questionnaire for Chinese school-age children (FFEQ-SC), including physical environment (healthy/unhealthy food availability), sociocultural environment (caregiver's FNL, family feeding patterns, meal practices, and eating rules, et al.), and family sociodemographic characteristics (children's caregivers and their educational level). The validation analysis showed the FFEQ-SC had an acceptable internal consistency (Cronbach's $\alpha = 0.78$) and construct validity (with fit indexes ranging from 0.85 to 0.92), hence it could potentially be used as an instrument to assess FFE for Chinese children.

It was found in this study that, overall 68.9% of the children's families had a high level of total FFE (≥ 60 of total score), but the findings could not be compared directly among studies for the uncomparable contexts of diverse FFE models and assessment instruments. As for family feeding patterns, most families were classified to be restricted (61.3%), and less were enforced (20.2%) or permissive (18.5%). Over a half families had eating rules (65.3%). A cross-sectional survey in 396 Australian parents of 3 to 5 year-old children showed that the majority of families (87%) ate most meals at a table, 59% of parents restricted dessert when their child did not

have dinner, 29% rewarded their child with dessert for finishing dinner, only 4% allowed their child to access snacks themselves, and fewer than half (39%) kept both fruit and vegetables in a ready-to-eat, accessible format [26]. An observational cohort study of 699 American children aged 6 to 11 years and their parents showed a prevalent use of encouragement/modeling and restrictive feeding practices and a high availability of low-calorie/nutrient-dense foods in the home, and other parenting and food availability measures were near the middle of the possible score range [20]. The Above studies agreed that compared to permission pattern, more families restricted children's eating

Undoubtedly, the potential impact of FFE on children's food choice and diet quality is particularly relevant [23, 27-31]. A systematic review (14 studies published between 1994 and 2017) indicated that family environmental factors (household food availability, caregivers' nutritional knowledge and family income) were consistently associated with children's food consumption and micronutrient intake [22]. But it is noteworthy that hiding behind the dietary behavior and food intake is the FNL [8, 15]. A cross-sectional study of 101 parent-child dyads showed that for every 1% increase in Nutrition Literacy Assessment Instrument for Parents (NLit-P), there was a 0.51 increase in child diet quality (Healthy Eating Index) [32]. So far, few studies have focused on the effect of FFE on individual FNL. We previously developed the food and nutrition questionnaire for Chinese school-age children (FNLQ-SC) to analyze relations of different FFE factors with children's FNL. The overall questionnaire had acceptable internal consistency (Cronbach's $\alpha = 0.698$), but the Cronbach's α coefficient of various dimensions was low, ranging from 0.148 to 0.452. One possible explanation is that internal consistency reliability values depend on the number of items in the scale [16], and the "planning", "selection", and "preparation of food" dimensions consisted of two, four and two components respectively. Other possibilities may be poor interrelation between components and heterogeneous constructs [33], sample size, and content overlap in different dimensions, and so on. However, lower reliability estimates do not necessarily negate the value of the dimensions since the expert panel rated the components as relevant. Without evidence of acceptable internal consistency, we recommend the total score to be used instead of the subscale (dimension) scores. Besides, the Pearson correlation coefficients between the dimensions (knowledge and understanding, selecting food, eating) and the overall questionnaire were more than 0.6, which indicated a strong correlation. Overall, the FNLQ-SC could be used to assess FNL for Chinese children, but it needs further revision.

The FFE factors, especially the family caregiver (father), and caregiver's educational level and nutrition literacy, were associated with children's FNL. An Iranian study on 803 students aged 10–12 years also identified significant association between total FNL and parent's education [18]. Note that in all FNL dimensions the score of children's healthy "eating" was positively related with family caregiver (father), caregiver's educational level and nutrition literacy, family economic status, and eating rules. Numerous studies have reported the similar association between caregivers' nutritional knowledge, education and family income with children's healthy food consumption and dietary pattern [22, 30, 34]. Another crucial result was that children with higher level of caregiver's FNL were less likely to be overweighted or obese (OR=0.043, 95%CI: 0.292-0.981, $P < 0.05$). These findings must therefore be involved with caution in children's health interventions

This study did not detect a strong relationship between family feeding patterns and food availability with children's eating dimension score of FNL, which is controversial with prior studies [22, 23]. For example, a Cochrane review showed parents' child-feeding practice may lead to slight increases in fruit and vegetable consumption in children [23]. The inconsistency might stem from the differences of FFE assessment and dietary investigation methods, thus we need further exploration. Also the study did not show any significant relations of family feeding patterns and meal practices with children's FNL, and future research should adopt more rigorous methods to advance the field.

To conclude previous studies focused on the impact of food environment on eating behavior and food choice. Based on these, this study further explored the relations of FFE factors with individual knowledge and skill (FNL) to make appropriate nutrition decisions, and the results might help to understand the interplay of contextual factors and personal behaviors among children. The study conclusively showed FFE, especially caregivers and their educational level and nutrition literacy, were significantly related with children's FNL and overweight risk. The findings highlight the importance of targeting nutritional knowledge and skill of family caregivers to facilitate the knowledge and ability of children to plan, select, prepare and eat foods, to maintain a healthy diet and good health.

Limitation

While developing an appropriate measuring instrument, the design and validation is of fair importance. Regarding this, the present study is limited in several ways. Firstly, the assessment questionnaires of family food environment (FFEQ-SC) and food and nutrition literacy (FNLQ-SC) both had acceptable internal consistency and construct validity, however, the internal consistency for skill dimension

of FNLQ-SC was below the expected value, the exploratory factor analysis (EFA) model slightly differed from the conceptual framework of FNL, and the confirmatory factor analysis (CFA) of them two showed high acceptability but unsatisfying goodness of fit in general. On the other hand, the two questionnaires have not been widely used and validated. Consequently, in this study, the conclusion should be drawn prudently.

Secondly, the current study was unable to identify the cut-off point. The obstacle was modified by introducing an alternative percentile (P_{60}) selected from literatures, or treating the data as continuous variable. Besides, the components and dimensions of FFE and the framework of FNL failed to be interacted. and should be analyzed in a big size population. Researchers must advance in this field on a broader scale.

Apart from the above, considering the representativeness and size of the sample, and the complexity of children's dietary behavior and food choice, our conclusion should be further verified in another population. And finally, caution should be applied in the weakness that this study has not investigated the school and neighborhood environment, which could influence children's FNL by nutrition education, advertisement and related information.

Conclusion

Family caregivers and their nutritional literacy, were related with children's FNL and overweight risk. These findings highlight the importance of targeting nutritional knowledge of family caregivers to facilitate the children's FNL to maintain good health. However, the conclusion here requires further validation in another population. Overall, the health promotion intervention of children ought to be extended from the child itself to the whole family, especially their caregivers

Abbreviations

FFE: Family Food Environment; FNL: Food and Nutrition Literacy; FFEQ-SC: the Family Food Environment Questionnaire for Chinese School-Age Children; FNLQ-SC: the Food and Nutrition Literacy Questionnaire for Chinese School-Age Children; NHANES: American National Health and Nutrition Examination Survey; CHNS: China Health and Nutrition Survey; ANGELO: Analysis Grid for Elements Linked To Obesity; HBSC: Health Behavior in School-Aged Children; GFI: Goodness of Fit Index; AGFI: Adjusted Goodness of Fit; NFI: Normed Fit Index; IFI: Incremental Fit Index; CFI: Comparative Fit Index; RMR: Root Mean Square Residual; RMSEA: Root Mean Square Error of Approximation; EFA: Exploratory Factor Analysis.

Declarations

Ethics approval and consent to participate

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study participants were approved by the Peking University Institutional Review Board (Beijing, China), IRB00001052-17115. Written informed consent was obtained from all subjects.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing Interests

None.

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Authors' contributions

conceptualization, LNN, SX and ZWL; methodology, LNN, SX and LT; formal analysis, LNN, SJ, LT; writing—original draft preparation, LNN and SX; writing—review and editing, LNN, LT, SJ, ZWL; project administration, ZWL. All authors reviewed and approved the final manuscript.

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References

1. Zhen S, Ma Y, Zhao Z, et al. Dietary pattern is associated with obesity in Chinese children and adolescents: data from China Health and Nutrition Survey (CHNS)[J]. *Nutr J*, 2018,17(1):68. DOI: 10.1186/s12937-018-0372-8.
2. Liu D, Zhao L Y, Yu D M, et al. Dietary Patterns and Association with Obesity of Children Aged 6-17 Years in Medium and Small Cities in China: Findings from the CNHS 2010-2012[J]. *Nutrients*, 2018,11(1):3. DOI: 10.3390/nu11010003.
3. FAO I U W A. The State of Food Security and Nutrition in the World 2019. Safeguarding against economic slowdowns and downturns.[Z]. Roma: FAO, 2019.
4. Bundy D A P, de Silva N, Horton S, et al. Investment in child and adolescent health and development: key messages from Disease Control Priorities, 3rd Edition[J]. *The Lancet*, 2018,391(10121):687-699. DOI: [https://doi.org/10.1016/S0140-6736\(17\)32417-0](https://doi.org/10.1016/S0140-6736(17)32417-0).
5. Sun S, He J, Fan X. Mapping and Predicting Patterns of Chinese Adolescents' Food Preferences[J]. *Nutrients*, 2019,11(9):2124. DOI: 10.3390/nu11092124.
6. Wu Y F, Wang D, Zhang X Y, et al. Dietary behavior of primary school children in Haidian District of Beijing and its relationship with family environment [J]. *Chin J Health*, 2020,41(01):55-57.
7. Scaglioni S, De Cosmi V, Ciappolino V, et al. Factors Influencing Children's Eating Behaviours[J]. *Nutrients*, 2018,10(6):706. DOI: 10.3390/nu10060706.
8. Azevedo P E, Thomas H, Samra H R, et al. Identifying attributes of food literacy: a scoping review[J]. *Public Health Nutr*, 2017,20(13):2406-2415. DOI: 10.1017/S1368980017001276.
9. Yuen E Y N, Thomson M, Gardiner H. Measuring Nutrition and Food Literacy in Adults: A Systematic Review and Appraisal of Existing Measurement Tools[J]. *Health literacy research and practice*, 2018,2(3):e134-e160. DOI: 10.3928/24748307-20180625-01.
10. Guo S, Armstrong R, Waters E, et al. Quality of health literacy instruments used in children and adolescents: a systematic review[J]. *BMJ open*, 2018,8(6):e20080. DOI: 10.1136/bmjopen-2017-020080.
11. Doustmohammadian A, Omidvar N, Keshavarz-Mohammadi N, et al. Developing and validating a scale to measure Food and Nutrition Literacy (FNLIT) in elementary school children in Iran[J]. *PloS one*, 2017,12(6):e179196. DOI: 10.1371/journal.pone.0179196.
12. Stjernqvist N W, Elsborg P, Ljungmann C K, et al. Development and validation of a food literacy instrument for school children in a Danish context[J]. *Appetite*, 2021,156:104848. DOI: <https://doi.org/10.1016/j.appet.2020.104848>.
13. Amin S A, Lehnerd M, Cash S B, et al. Development of a Tool for Food Literacy Assessment in Children (TFLAC)[J]. *J Nutr Educ Behav*, 2019,51(3):364-369. DOI: <https://doi.org/10.1016/j.jneb.2018.12.006>.
14. Liu T, Su X, Li N, et al. Development and validation of a food and nutrition literacy questionnaire for Chinese school-age children[J]. *PLoS One*, 2021,16(1):e244197. DOI: 10.1371/journal.pone.0244197.
15. Vaitkeviciute R, Ball L E, Harris N. The relationship between food literacy and dietary intake in adolescents: a systematic review[J]. *Public Health Nutr*, 2015,18(4):649-658. DOI: 10.1017/S1368980014000962.
16. Doustmohammadian A, Omidvar N, Keshavarz-Mohammadi N, et al. Low food and nutrition literacy (FNLIT): a barrier to dietary diversity and nutrient adequacy in school age children[J]. *BMC Res Notes*, 2020,13(1):286. DOI: 10.1186/s13104-020-05123-0.

17. Ahmadpour M, Omidvar N, Doustmohammadian A, et al. Children Food and Nutrition Literacy - a New Challenge in Daily Health and Life, the New Solution: Using Intervention Mapping Model Through a Mixed Methods Protocol[J]. *J Med Life*, 2020,13(2):175-182. DOI: 10.25122/jml-2019-0025.
18. Doustmohammadian A, Keshavarz M N, Omidvar N, et al. Food and nutrition literacy (FNLIT) and its predictors in primary schoolchildren in Iran[J]. *Health Promot Int*, 2019,34(5):1002-1013. DOI: 10.1093/heapro/day050.
19. Boucher B A, Manafò E, Boddy M R, et al. The Ontario Food and Nutrition Strategy: identifying indicators of food access and food literacy for early monitoring of the food environment[J]. *Health Promot Chronic Dis Prev Can*, 2017,37(9):313-319. DOI: 10.24095/hpcdp.37.9.06.
20. Couch S C, Glanz K, Zhou C, et al. Home food environment in relation to children's diet quality and weight status[J]. *J Acad Nutr Diet.*, 2014,114(10):1569-1579. DOI: 10.1016/j.jand.2014.05.015.
21. Khorramrouz F, Doustmohammadian A, Eslami O, et al. Relationship between household food insecurity and food and nutrition literacy among children of 9-12 years of age: a cross-sectional study in a city of Iran[J]. *BMC research notes*, 2020,13(1):433. DOI: 10.1186/s13104-020-05280-2.
22. Sirasa F, Mitchell L J, Rigby R, et al. Family and community factors shaping the eating behaviour of preschool-aged children in low and middle-income countries: A systematic review of interventions[J]. *Prev Med*, 2019,129:105827. DOI: 10.1016/j.ypmed.2019.105827.
23. Hodder R K, O'Brien K M, Stacey F G, et al. Interventions for increasing fruit and vegetable consumption in children aged five years and under[J]. *Cochrane Database Syst Rev*, 2018,5(5):D8552. DOI: 10.1002/14651858.CD008552.pub5.
24. Swinburn B, Egger G, Raza F. Dissecting obesogenic environments: the development and application of a framework for identifying and prioritizing environmental interventions for obesity[J]. *Prev Med*, 1999,29(6 Pt 1):563-570. DOI: 10.1006/pmed.1999.0585.
25. Swinburn B, Egger G, Raza F. Dissecting obesogenic environments: the development and application of a framework for identifying and prioritizing environmental interventions for obesity[J]. *Prev Med*, 1999,29(6 Pt 1):563-570. DOI: 10.1006/pmed.1999.0585.
26. Wyse R, Campbell E, Nathan N, et al. Associations between characteristics of the home food environment and fruit and vegetable intake in preschool children: a cross-sectional study[J]. *BMC Public Health*, 2011,11:938. DOI: 10.1186/1471-2458-11-938.
27. Hendrie G, Sohonpal G, Lange K, et al. Change in the family food environment is associated with positive dietary change in children[J]. *Int J Behav Nutr Phys Act.*, 2013,10:4. DOI: 10.1186/1479-5868-10-4.
28. Wang J, Fielding-Singh P. How Food Rules at Home Influence Independent Adolescent Food Choices[J]. *J Adolesc Health.*, 2018,63(2):219-226. DOI: 10.1016/j.jadohealth.2018.02.010.
29. Jackson J A, Smit E, Branscum A, et al. The Family Home Environment, Food Insecurity, and Body Mass Index in Rural Children[J]. *Health Educ Behav.*, 2017,44(4):648-657. DOI: 10.1177/1090198116684757.
30. Stahlmann K, Hebestreit A, DeHenauw S, et al. A cross-sectional study of obesogenic behaviours and family rules according to family structure in European children[J]. *Int J Behav Nutr Phys Act*, 2020,17(1):32. DOI: 10.1186/s12966-020-00939-2.
31. Hebestreit A, Intemann T, Siani A, et al. Dietary Patterns of European Children and Their Parents in Association with Family Food Environment: Results from the I.Family Study[J]. *Nutrients*, 2017,9(2):126. DOI: 10.3390/nu9020126.
32. Gibbs H D, Kennett A R, Kerling E H, et al. Assessing the Nutrition Literacy of Parents and Its Relationship With Child Diet Quality[J]. *J Nutr Educ Behav*, 2016,48(7):505-509. DOI: 10.1016/j.jneb.2016.04.006.
33. Tavakol M, Dennick R. Making sense of Cronbach's alpha[J]. *Int J Med Educ*, 2011,2:53-55. DOI: 10.5116/ijme.4dfb.8dfd.
34. Hinnig P F, Monteiro J S, de Assis M, et al. Dietary Patterns of Children and Adolescents from High, Medium and Low Human Development Countries and Associated Socioeconomic Factors: A Systematic Review[J]. *Nutrients*, 2018,10(4):436. DOI: 10.3390/nu10040436.

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