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Article

Development and Validation of Nutrition Literacy Questionnaire for Chinese Pre-School Children

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Abstract: Background: This study aims to develop and validate the Nutrition Literacy Questionnaire for Chinese Pre-school Children (NLQ-PSC). **Methods**: The reliability of the questionnaire was determined by internal consistency, the construct validity was assessed by exploratory factor analysis (EFA) and confirmatory factor analysis (CFA), and the content validity was assessed by the Pearson correlation coefficient. In order to analyze the ap-plication of NLQ-PSC, we conducted a cross-sectional study among 790 pre-school children. **Results**: From the literature review and qualitative methods, NLQ-PSC was developed, including 2 di-mension of knowledge and 4 practice dimensions. NLQ-PSC questionnaire had good reliability and validity. The average NLQ-PSC score of all participants was 64.1 11.0, and we found that older children, girl, children who had well-educated parents presented higher nutrition literacy. **Conclusions**: NLQ-PSC had been validated and have shown good reliability and validity, and it could be con-sidered as a reliable tool to assess Chinese preschool children.

Keywords: pre-school children; nutrition literacy; nutrition literacy questionnaire; instrument assessment

1. Introduction

Infants and young children begin to gradually add complementary foods after reaching the age of 6 months. During the critical developmental window of 7-24 months, dietary patterns transition toward adult-like food types and structures. However, during this period, children develop autonomy and begin to show different interests and preferences in food, and are prone to picky eating. Moreover, preschool children are not easy to concentrate and are easily disturbed by the environment, such as television, toys, games, etc., which will reduce children's attention to food, affect the amount of food eaten and the digestion and absorption of food. At the same time, preschool children's self-care ability is constantly improving, and their curiosity, learning ability and imitation ability are enhanced, which is an important stage for children to improve their nutritional cognition and cultivate eating habits. Early childhood is a critical period for forming healthy dietary behaviors that may track into later life. Consumption of fruit and vegetables in childhood persist into later childhood and is associated with reductions in non-communicable diseases in adulthood. Interventions in early childhood has been indicated in the increasing consumption in vegetables [1].

Nutrition literacy (NL) is defined as the ability to obtain, process, understand and use correct nutrition information and nutritional knowledge to make appropriate decisions about food choices [2]. High NL help people to enhance nutrition food intake and the quality of diet. The Chinese government released the “The Healthy China 2030 Plan”, with the aim of improving the nutrition and health literacy.

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Therefore, NL assessment tools play an important role in monitoring and evaluation of nutrition literacy. Nowadays, there are nutrition literacy assessment tools such as the Nutrition Literacy Assessment Instrument (NLAI) [3], the Food and Nutrition Literacy (FNLIT) [4], the Nutrition Literacy Scale (NLS) [5], the Critical Nutrition Literacy Scale (CNL) [6], the Newest Vital Sign (NVS) [7] and the NLit-IT [8]. In China, nutrition literacy assessment tools were established from school-age children, pregnant women, adults to the elderly [9-12]. However, none of these tools can be applied among pres-choolers due to the limited cognition, culture and differences in dietary habits.

According to Piaget's theory, preschool children begin to pay attention to the characteristics of certain aspects of things, and their memory awareness and memory methods continue to improve, and the memory content is more refined [13]. Pre-school children are able to evaluatively categorize foods as healthy or unhealthy [14], and their nutrition knowledge can influence their food choices [1,15]. At present, there is lack of NL assessment tools for pre-school children. Researches among preschool children are mainly divided into two categories: cognitive and behavioral. Cognitive researches mainly focus on children's cognition of food and nutrition and the influencing factors, and are often combined with nutrition education intervention programs [15-17]. Behavioral research mainly focuses on the formulation and application of scales, and explores the current status and influencing factors of children's eating behaviors [18-20]. Both types of research are relatively one-sided, and cannot represent the assessment of nutritional literacy. In addition, the data of the studies among pre-school children are usually collected from the caregivers (parents or teachers), without taking into account that their limited level of cognition also has the ability to accept and finish the survey.

Thus, our purpose is to develop the nutrition literacy questionnaire for Chinese pre-school children (NLQ-PSC), with the expectation of providing an effective tool for assessing and monitoring the status of NL of the pre-school children in China, while providing further nutrition education targets.

2. Materials and Methods

This study could be divided into 2 parts: the development of questionnaire and the validation of the questionnaire.

2.1. Development of the Nutrition Literacy Questionnaire

2.1.1. Stage 1: The Construction of the Core Components of Nutrition Literacy for Pre-School Children

Based on literature review, group discussion and expert consultation, the framework system of nutrition literacy were established. Recommendations related to nutrition and diet for pre-school children were selected from literature and guidelines about children's cognition, growth, nutrition, diet and education, and were formulated as the preliminary core components list of nutrition literacy. Using a two-round Delphi consultation, 9 experts who had more than 10 years of working experience and obtained at least a deputy senior title in the field of nutrition, child and adolescent health, health education were invited to rate, discuss and modify the scientific, rationality, applicability and representativeness of the core components of nutrition literacy for pre-school children via Email.

The detailed elaboration of the methodology and results of the two-round Delphi survey, has been published elsewhere [21]. The final core components of the pre-school children nutrition literacy were used to set up as the questionnaire (Table 1).

Table 1. The core components of nutrition literacy for pre-school children.

Domain	Dimension	Component
Knowledge and Understanding	Knowing about food	1. Recognizing common food. 2. Simply classifying food.

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Living and dietary behaviors	Knowing about the characteristic of food	3. Knowing about the sources of food.
		4. Knowing about the nutrition characteristic of food.
	Selecting food	5. Simply identifying fresh and sanitary food.
		6. Light Diet, eating fewer salts, oils and sugars.
		7. Drinking milk and plenty of water every day and rejecting or consuming fewer sugar-sweetened beverages.
		8. Choosing snacks appropriately, and fruits, milk and nuts are preferred.
		9. Treasuring food and eliminating waste.
	Eating behaviors	10. No picky eating.
		11. Focus on eating during meal and chewing slowly without distraction and delay.
		12. Eating independently and being able to learn and gradually master the use of tableware.
	Eating safely	13. Washing hands before eating.
	Physical activities	14. Participating in various kinds of physical activities actively and reducing sedentary behaviors.

2.1.1. Stage 2: The Development of Questionnaire

Taking consideration of the emergence, developing but limited cognitive abilities of pre-school children and the important role parents played in children's living and dietary behavior, we assessed their nutrition literacy from both direct (children) and indirect (parent) sides. Based on the core components, we designed the questionnaire to measure the nutrition literacy and for a comprehensive assessment, some one component of nutrition literacy corresponded to more than one question. Finally, a pool of 35 questions was generated, which was mainly composed of children's and parental sections, including 21 questions for children and 14 questions for parents. In children's section, accounting for the limited language comprehension and cognitive skills of pre-school children, the questions consisted of picture description questions ("Please identify and verbalize the names of food depicted in the images"), single choice questions ("Which of these two foods, apples and candy, do you think will lead to weight gain if consumed excessively?") multiple choice questions ("Which types of snacks and drinks would you prefer to choose?") and operation questions ("Please organize the food cards by categorizing them according to food types").

For parent's section, the total questionnaire was composed of basic information and the nutrition literacy of children via electronic questionnaire. The questions of nutrition literacy included single, multiple choices questions (children's common selection of snacks and beverages) and fill-in-the-blank questions (children's duration of physical activities) which were related to the living and dietary behavior of children. Single choice questions related to the frequency and food consumption were rated on a 5-point Likert-type scale, ranging from "not at all" (or "< 400 ml") to "always" (or "≥ 1000 ml").

Accounting for the significant developmental changes in cognitive level of children at different ages between 2 to 6 years old, children under 4 could skip the questions beyond their comprehension. According to the evaluation and adjustment suggestions from experts in nutrition education and senior teachers in kindergarten, redundant items were eliminated and the final questionnaire for children aged 2 to 4 included 35 questions while 33 questions for children aged 4 to 6. Children's and parental section of the questionnaire were given an equal weight, and the total questionnaire had a maximum score of 100 points. Based on the rating on each question from experts and professionals, each question was given different weight.

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2.2. Validation of the Nutrition Literacy Questionnaire

2.2.1. Data Collection

Children and their parents were recruited via convenience sampling in kindergartens in Beijing, Shandong, Sichuan and Hunan from November 2019 to October 2021. Eligible children aged 2 to 6 who were able to communicate, understand well and without severe birth defects, diseases and one of their parents were enrolled in the survey. Children's researches were conducted by a single researcher through a face-to-face method while parents completed the electronic questionnaire released by researchers via smart phone. Based on this, we investigated 1097 children and 1052 parents in total. We also collected information on parents' education level and annual family income. After combining the data of children's questionnaire with parental section and matching the data according to children's name, gender and area, we finally collected 739 child-parent pairs and the pairing rate was 68.5%.

Before the investigation, we got face-to-face verbal confirmation from children and written informed consent was obtained from their parents, and we kept all information confidential. This study was approved by the medical ethics committee of the Peking University Institutional Review Board (approval number: IRB00001052–19120).

2.2.2. Reliability and Validity Tests

The reliability and validity tests were based on the core components of the nutrition literacy for pre-school children. In order to reduce the effects of cognition difference, data from children aged over 4 were used for reliability and validity analysis. Due to the different survey respondents between 2 sections of questionnaire, we tested the reliability and validity of the questionnaire for children and parents separately. Following the 5–10 times of the amount of questions, 210 children and 140 parents were randomly selected as the sample for the questionnaire reliability and validity analysis.

Cronbach's alpha coefficient was used to measure the internal consistency and test-re-test reliability was examined by Spearman Brown coefficient (split-half analysis). Reliability coefficients of 0.6 or higher were considered acceptable.

Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were caried out to explore the construt validity of the questionnaire. The suitability of the data for EFA was performed based on the value of Kaiser-Meyer-Olkin (≥ 0.6) and Bartlett's test of sphericity ($p < 0.05$). A maximum variance rotation and principal axis factoring (PAF) were used to explore the existing factorial pattern. CFA was applied to verify the compatibility between the actual measurement of data and the theoretic framework. Chi-squared ratio to degree of freedom (χ^2/df), root mean square error of approximation (RMSEA), adjusted goodness of fit index (AGFI), goodness of fit index (GFI), parsimony normed fit index (PNFI) and parsimony goodness of fit index (PGFI) were used to evaluate the model. Smaller RMSEA value indicated a better fit: values ≤ 0.05 was considered a good fit (0.05 < RMSEA value ≤ 0.08 was acceptable). Larger AGFI, GFI values (> 0.90), PNFI and PGFI values (> 0.50) suggested a good model fit.

2.3. Statistical Analysis

Epidata 3.1 software (The Epi Data Association, Odense, Denmark) was used for data entry, and all data received were double-checked. Description information was presented as mean ± standard deviation (SD), numbers (n) or proportions (%). Reliability analysis was tested using both Cronbach's alpha and Spearman-Brown coefficients. The quality of the exploratory factor analysis models was assessed using the KMO, Bartlett's test of sphericity and total variance. Multivariate liner regression model was used to investigate factors that affect the nutrition literacy. Logistic regression model was performed to analyze the factors affecting the nutrition literacy level of pre-school children. Performed via IBM AMOS V.22.0 software (IBM, Aromonk, NY, USA), confirmatory factor analysis

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was expressed by χ^2/df, RMSEA, GFI, AGFI, PCFI and PNFI. Other statistical analyses were conducted via IBM SPSS V.23.0 software (IBM, Aromonk, NY, USA). A two-side p values < 0.05 were considered statistically significant.

3. Results

3.1. Demographic Characteristics of Participants

While 52.4% were boys, a total of 739 children aged from 2 to 6 years old, and one of their parents participated in the study and the statistic were used for the questionnaire application analysis. Among these, 210 children samples (28.4% of the subjects) and 140 parents samples (18.9% of the subjects) were randomly selected for the reliability and validity test of the questionnaire. Table 1 shows a summary of the sociodemographic characteristics of the total study and reliability and validity tests samples.

3.2. Reliability and Validity Tests

3.2.1. Reliability

For the section of children questionnaire, acceptable reliability was supported by internal consistency (Cronbach's α was 0.660) and split-half reliability (Spearman-Brown coefficient was 0.729). The Cronbach's α coefficients for the 2 dimensions (basic knowledge and living and dietary behaviors) were 0.612 and 0.422 respectively. For the parents' questionnaire, the Cronbach's α coefficient was 0.628 and the Spearman-Brown coefficient was 0.642.

3.2.2. Content Validity

In children's questionnaire, the Pearson correlation coefficient between 2 domains (knowledge and understanding, living and dietary behaviors) was 0.306, and the correlation coefficient between each dimension and overall questionnaire was 0.841 and 0.773 ($p < 0.05$), respectively, which indicated a very strong relationship. The correlation coefficients between each component and the "basic knowledge" domain ranged from 0.340 to 0.654, while the coefficients ranged from 0.251 to 0.549 in the "living and dietary behaviors" domain (the detailed correlation coefficients are shown in Appendix A, Table A1). In parents' questionnaire, all of the 14 components belonged to the "living and dietary behaviors" domain, and the correlation coefficients between each component and the "living and dietary behaviors" domain ranged from 0.214 to 0.542 (the detailed correlation coefficients are shown in Appendix A, Table A2). For the entire questionnaire, the Pearson correlation coefficient between knowledge and understanding domain and the living and dietary behaviors domain was 0.292 ($p < 0.001$), and the correlation coefficients between the two dimensions and the total score were

3.2.3. Construct Validity

For the children questionnaire, an adequate KMO value and significant Bartlett's test of sphericity (0.692, $\chi^2 = 651.701$, $p < 0.001$), indicating the questionnaire was suitable for factor analysis. Six factors with eigenvalues greater than 1.0 were extracted with 49.6% of the total variance explained. Considering the KMO value (0.737) and the significance of Bartlett's sphericity test ($\chi^2 = 366.609$, $p < 0.001$), the parents' questionnaire was also determined to be suitable for factor analysis. Four factors with eigenvalues greater than 1.0 were extracted from the parents' questionnaire, accounting for 53.211% of the variance.

The validation factor analysis supported the structure of the children questionnaire with χ^2/df = 1.378 (< 3.0). The RMSEA was 0.043 (< 0.05). The GFI and AGFI values at 0.901 and 0.875 were satisfactory as both values were close to 0.90 for a good model. The PCFI (0.739) and the PNFI (0.546) values were greater than 0.5. For the parents' questionnaire, adequate model fit was defined as the

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χ^2/df = 1.318 and the RMSEA = 0.048 (< 0.08). The GFI, AGFI, PNFI and PCFI value was 0.914, 0.873, 0.589 and 0.720, respectively, suggesting good construct validity of the questionnaire.

3.3. Status of Nutritional Literacy Among Pre-School Children

On the basis that each part of the questionnaire has a good reliability and validity, we combined the data of children's and parents' questionnaire and calculated the score of nutrition literacy among pre-school children (Table 2). The average score for pre-school children was 64.1±11.0, while the maximum and minimum were 93.2 and 26.7, respectively. As shown in Table 2, girls presented higher nutrition literacy than boys in living and dietary dimensions (p<0.001). Older children showed higher nutrition literacy, not only in knowledge and understanding dimension, but also in living and dietary behavior (p_{all}<0.001). Compared to the children who lived in Hunan and Shandong, children in Beijing and Sichuan had higher nutrition literacy, and children in Beijing performed significantly better in both knowledge and behavior dimension than children in Hunan (p_{all}<0.001). For nutrition literacy, there were no significant difference among different weight status children (p>0.05), but the overweight children had more knowledge and understanding than the normal children (p=0.02). Children with higher education-level-parent showed higher nutrition literacy and performed better in both two dimensions. Children with higher average monthly household income, specifically more than 3000 RMB per month, had higher nutrition literacy and performed better in knowledge and understanding dimension (p_{all}<0.001). Children with more than 5000 RMB household income per month, performed better in living and dietary behavior than those whose household income less than 1000 RMB per month (p<0.001). As shown in Table 3, the Pearson correlation coefficients between the total score and different dimensions ranged from 0.218-0.702, showing a strong correlation with the overall questionnaire (p<0.001).

Table 2. Demographic characteristics of participants, n (%).

Characteristics	Total (n=739)	Reliability and validity study among children (n=210)	Reliability and validity study among parents (n=140)
Gender			
Boys	387 (52.4)	116 (55.2)	78 (55.7)
Girls	352 (47.6)	94 (44.8)	62 (44.3)
Age (years old)			
2~4	294 (39.8)	-	-
4~6	445 (60.2)	210	140
Residence			
Beijing	230 (31.1)	75 (35.7)	56 (40.0)
Shandong	115 (15.6)	30 (14.3)	23 (16.4)
Sichuan	83 (11.2)	24 (11.4)	19 (13.6)
Hunan	311 (42.1)	81 (38.6)	42 (30.0)
BMI (kg, mean±SD)	15.9±2.0	15.7±2.1	-
Parents' education level			
Lower junior college degree	393 (53.2)	105 (50.0)	61 (43.6)
Junior college degree or above	343 (46.4)	104 (49.5)	78 (55.7)
Average monthly household income			
< 1000 RMB	164 (22.2)	39 (18.6)	23 (16.4)
1000~3000 RMB	172 (23.3)	49 (23.3)	24 (17.1)
3000~5000 RMB	69 (9.3)	16 (7.6)	13 (9.3)
≥ 5000 RMB	332 (44.9)	106 (50.5)	79 (56.4)

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Table 3. Distribution of nutrition literacy among pre-school children (mean ± SD).

Variables (Subjects)	Total Score	Knowledge and Understanding	Living and Dietary Behavior
Total (739)	64.1±11.0	21.7±6.3	42.3±7.4
Gender			
Boys (387)	63.3±10.9	21.8±6.2	41.5±7.6
Girls (352)	64.9±11.0	21.7±6.3	43.2±7.1*
t	-1.932	0.306	-3.146
p	0.054	0.759	0.002
Age (years old)			
2~3 (18)	58.9±11.6[ab]	19.3±6.7[a]	39.6±7.4[a]
3~4 (275)	59.9±10.5[ab]	18.6±6.0[ab]	41.3±7.0[a]
4~5 (300)	63.9±9.8[a]	22.1±5.4[a]	41.7±7.4[a]
5~6 (146)	73.1±8.5	27.2±3.9	45.9±6.9
F	58.673	78.902	15.412
p	<0.001	<0.001	<0.001
Residence			
Beijing (230)	70.0±9.6[cd]	25.1±4.3[d]	44.9±7.7[cd]
Shandong (115)	67.6±9.0[d]	24.9±5.0[d]	42.7±6.8[d]
Sichuan (83)	68.3±9.2[d]	25.1±4.2[d]	43.1±6.7[d]
Hunan (311)	57.3±9.3	17.2±5.5	40.1±6.8
F	96.796	270.421	20.948
p	<0.001	<0.001	<0.001
Weight status			-
Wasting (13)	63.1±10.7	22.8±6.1	40.2±7.1
Normal (673)	63.9±11.0	21.5±6.3[e]	42.4±7.4
Overweight (35)	67.9±10.4	24.7±5.2	43.1±7.3
Obesity (16)	63.6±9.9	23.4±6.6	40.2±6.4
F	1.464	3.428	0.959
p	0.223	0.017	0.412
Parent's education level			
Lower junior college degree (393)	59.4±10.0	19.0±6.1	40.3±7.0
Junior college degree or above (343)	69.4±9.5	24.9±4.9	44.6±7.2
t	-13.963	12.927	-8.075
p	<0.001	<0.001	<0.001
Average monthly household income			
< 1000 RMB (164)	57.9±9.5[gh]	17.1±5.6[fgh]	40.8±6.9[h]
1000~3000 RMB (172)	60.1±10.9[gh]	19.2±6.3[gh]	41.0±7.0
3000~5000 RMB (69)	65.8±9.9	23.8±5.4	42.0±7.4
≥ 5000 RMB (332)	68.8±9.7	24.9±4.6	43.9±7.6
F	55.443	237.302	9.540
p	<0.001	<0.001	<0.001

[a] Compared to pre-school children aged 5~6, the score was different ($p < 0.05$). [b] Compared to pre-school children aged 4~5, the score was different ($p < 0.05$). [c] Compared to pre-school children in Shandong, the score was different ($p < 0.05$). [d] Compared to pre-school children in Hunan, the score was different ($p < 0.05$). [e] Compared to overweight pre-school children, the score was different ($p < 0.05$). [f] Compared to pre-school children with average monthly household income of 1000~3000 RMB, the score was different ($p < 0.05$). [g] Compared to pre-school children with average monthly household income of 3000~5000 RMB, the score was different ($p < 0.05$). [h] Compared to pre-school children with average monthly household income of 5000 RMB or above, the score was different ($p < 0.05$).

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3.4. Factors Related to the Nutritional Literacy Among Preschool Children

Multiple linear regression analysis indicated that age, gender, residence, parent's education level and children's weight status were predictors of nutrition literacy in pre-school children (shown in Table 4). Older children and children who were girls, with higher education level parents, overweight would have significantly higher nutrition literacy, while children who lived in lower-income region would have lower nutrition literacy. Set a score of 80 as the cut-off point for excellent nutrition literacy, logistic regression was also conducted to explore the influencing factor of pre-school children nutrition literacy, and results were shown in Table 5. Similarly, excellent scores were more likely to be older children, girls and children with high-educated parents. Children who lived in lower income region showed lower nutrition literacy. Unlike the multiple linear regression results, compared to children with average monthly household income less than 1000 RMB, children with average monthly household income more than 3000 RMB had more excellent nutrition literacy (3000-5000 RMB: OR=0.003, 95%CI: 0.001-0.787, p=0.03; >5000 RMB: OR=0.004, 95%CI: 0.002-0.913, p=0.04).

Table 4. Pearson correlation coefficient among dimensions of NLQ-PSC.

	Total	Knowing about food	Knowing about the characteristic of food	Selecting food	Eating behavior	Eating safely	Physical activities
Total		0.643*	0.630*	0.641*	0.702*	0.370*	0.218*
Knowledge and Understanding	0.766*	0.751*	0.921*	0.152*	0.327*	0.162*	0.020
Living and Dietary Behavior	0.839*	0.312*	0.203*	0.772*	0.729*	0.413*	0.308*

* p<0.001.

Table 5. Multiple linear regression analysis of nutrition-literacy-related factors among Chinese pre-school children.

Variables	B	SE	β	t	p
Constant	65.84	0.97		67.89	<0.001
age	4.16	0.43	0.28	9.67	<0.001
Gender (ref: boys)	1.81	0.68	0.08	2.67	0.008
Residence (ref: Beijing)					
Shandong	-2.03	1.0	-0.07	-2.02	0.044
Hunan	-9.76	1.0	-0.44	-9.56	<0.001
Parent's education level (ref: lower junior college degree)	3.48	0.97	0.16	3.60	<0.001
Weight Status (ref: wasting)					
Overweight	3.97	1.60	0.08	2.47	0.014

Table 6. Logistic regression of association between nutrition literacy level and demographic characteristic among pre-school children.

Variables	B	SE	p	OR	95% CI	
Constant	-4.28	1.82	0.019	0.014		
age	0.970	0.207	<0.001	2.639	1.757	3.962
Gender (ref: boys)	0.797	0.320	0.013	2.218	1.184	4.1560.008
Residence (ref: Beijing)						
Hunan	-5.399	1.793	0.003	0.005	0.000	0.196
Parent's education level (ref: lower junior college degree)	1.026	0.472	0.03	2.789	1.106	7.036
Average monthly household income (ref: <1000 RMB)						

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3000-5000 RMB	-3.5	1.664	0.035	0.03	0.001	0.787
>5000 RMB	-3.208	1.59	0.044	0.04	0.002	0.913

4. Discussion

According to our knowledge, this is the first developed nutrition literacy assessment instrument for pre-school children in China. Covering 14 key components, grouped into 2 domains of 5 knowledge and 9 behaviors. The overall NLQ-PSC is an instrument with satisfactory reliability and validity, which can be used to measure the nutrition literacy of Chinese pre-school children.

A reliability test measure how consistent or stable the results of the questionnaire are. Due to the different respondents, we tested the reliability and validity of the questionnaire for children and parents separately. A value between 0.6 and 0.7 suggests an acceptable lever of reliability [22]. The Cronbach's α of overall questionnaire for both children and parents were above 0.6, which indicated our questionnaire had acceptable internal consistency. Due to the limited cognitive ability and attention time of preschool children, we did not set much questions, which may lead to low internal consistency. Additionally, there are many other possible reasons for a low α value, such as the small sample size, poor amount of questions in some dimension and the content overlap in different dimensions.

Content validity reflects whether the scale items meet the measurement purpose and requirements, while construct validity describes the matching degree between the theoretical hypothesis of the scale and the actual measurement value. Structural equation modeling analyses revealed a good fit to the data (children: $\chi 2/df = 1.378$, $p<0.001$, RMSEA= 0.043; parents: $\chi 2/df = 1.318$, $p<0.001$, RMSEA= 0.048). Theses result indicated that we successfully established the structural equation model of NQL-PSC, and the actual measurement basically aligns with the theoretical.

Through NLQ-PSC, we evaluated the nutrition literacy of 790 Chinese pre-school children, which average score was 64.1±11.0. The accuracy of the knowledge and understanding dimension was higher than that of the living and dietary behavior dimension. In the knowledge and understanding domain, the scores were not much different. For the living and dietary behavior domain, only half of the pre-school children made the right decision in selecting food and physical activities dimensions, which indicated that more outdoor activities should be encouraged.

Food preferences and dietary patterns are established during infancy and early childhood, setting the stage for healthy (or unhealthy) eating habits later in life [23,24]. A system review showed that education, interventions and care to preschoolers may improve child diet quality, but the evidence is very uncertain and likely increases fruit consumption, but healthy eating interventions likely result in little to no difference in consumption of non-core foods and sugar-sweetened beverages [1]. Instead, home food environment, parental healthy food intake, parental food literacy may have positive effect on preschoolers, improving their [25,26], indicating that food environment of preschoolers can be improved by improving the nutritional literacy of caregivers. Regrettably, we did not investigate children's dietary intake and the nutritional literacy of preschool parents or caregivers in our study. Further studies are wanted to explore the association between the nutrition literacy of parents or caregivers and the nutrition literacy, dietary behaviors, nutrition-related knowledge of preschoolers.

There are some advantages in our study. First, to our knowledge, this was the first reported assessment tool to evaluate the nutrition literacy level of preschoolers in China. Second, taking the Chinese Dietary Guidelines, publications of official or professional organizations (WHO, etc.) as the theoretical basis, and consulting with the senior experts from the fields of nutrition, children's health and health education, our assessment tool was supported by solid empirical and theoretical basis. Third, our assessment tool took the cognitive abilities of pre-school children into account and comprehensively assessed their nutritional literacy from both their own frontal survey and their parents' side survey. This was a breakthrough in the survey methodology of preschool children and it obtained a well reliability and validity.

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Undeniably, the limitations of this study were as follows: (1) The use of a convenience sample for surveying rather than a random sample affected the representativeness of the sample. (2) Some indicators in the process of questionnaire verification may only reach an acceptable level and can be improved in subsequent research. (3) Our study did not explore the relationship between nutritional literacy and overall dietary quality of preschool children, and did not find a relationship between nutritional literacy and body weight, which may be related to the limited representativeness of the sample size, and should be the main focus of attention in the next step to provide scientific evidence for children's nutrition education and nutrition improvement programs.

5. Conclusions

In conclusion, we had developed and validated the NLQ-PSC for Chinese pre-school children. Undeniably, the sample of this study is limited and a nationwide survey of Nutrition Literacy was necessary to identify the target population for further nutrition education to develop targeted interventions to improve nutrition literacy and dietary quality, thus further improving their health.

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Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy.

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Appendix A

Table A1. The correlation coefficients between each component and domain in children's questionnaire.

Domains	Component	n	The Pearson correlation coefficients	*p*
The basic knowledge domain	1	210	0.603**	<0.001
	2-3	210	0.654**	<0.001
	3-1	210	0.340**	<0.001
	3-2	210	0.455**	<0.001
	3-3	210	0.464**	<0.001
	4-1	210	0.456**	<0.001
	4-2	210	0.500**	<0.001
	5-1	210	0.460**	<0.001
	5-2	210	0.442**	<0.001
	9-1	210	0.481**	<0.001
	9-2	210	0.501**	<0.001
The living and dietary behaviors domain	6	210	0.481**	<0.001
	7	210	0.549**	<0.001
	8-1	210	0.372**	<0.001
	8-2	210	0.526**	<0.001

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	10	210	0.347**	<0.001
	11	210	0.328**	<0.001
	12-1	210	0.260**	<0.001
	12-2	210	0.410**	<0.001
	13	210	0.251**	<0.001
	14	210	0.445**	<0.001

** .Correlation is significant at the 0.01 level (2-tailed).

Table A2. The correlation coefficients between each component and domain in parents' questionnaire.

Domains	Component	n	The Pearson correlation coefficients	*p*
The living and dietary behaviors domain	1	140	0.507**	<0.001
	2	140	0.378**	<0.001
	3	140	0.495**	<0.001
	4	140	0.271**	<0.001
	5	140	0.683**	<0.001
	6	140	0.507**	<0.001
	7	140	0.542**	<0.001
	8	140	0.348**	<0.001
	9	140	0.483**	<0.001
	10	140	0.450**	<0.001
	11	140	0.432**	<0.001
	12	140	0.278**	<0.001
	13	140	0.214**	<0.001
	14	140	0.402**	<0.001

** .Correlation is significant at the 0.01 level (2-tailed).

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