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Cross-cultural adaptation and validation of the short nutritional literacy scale for young adults (18-35years) and analysis of the influencing factors

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Abstract

Objectives This study translated the short nutrition literacy scale for young adults (18–35 years) into Chinese, examined its reliability and validity, and analyzed its influencing factors.

Methods The scale was translated using a modified Brislin translation model. A convenience sample of 508 cases was selected for the survey. Content validity, structural validity, Cronbach's alpha coefficient, and test-retest reliability were used to evaluate the scale's reliability and validity. To screen the factors influencing nutrition literacy in young people.

Results The Chinese version of the Item-Level Content Validity Index (I-CVI) was 0.833 ~ 1, and the Scale-Level Content Validity Index/Average (S-CVI/Ave) was 0.908. The cumulative variance contribution of the scale was 51.029%, and the model was generally well-fitted. The Cronbach's alpha coefficient and retest reliability of the scale were 0.826 and 0.818. The results showed that the level of education, mother's education, nutrition-related courses, and frequency of attention to nutritional health information were the factors influencing the nutritional literacy of young people.

Conclusion The Chinese version of the S-NutLit Scale can effectively assess the nutrients of young Chinese people. Low levels of education, low levels of education of mothers, lack of exposure to nutrition-related courses, and low frequency of attention to nutritional health information can lead to lower levels of nutritional literacy among young people.

Keywords Young adults, Nutrition literacy, S-NutLit scale, Transcultural adaptation, Influencing factors

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Introduction

With the growth of the social economy and the increase in residents' income, Chinese residents' total amount and structure of food consumption have undergone significant changes, and dietary patterns and diet-related behaviors have become more diversified and modernized [1, 2]. Although the nutritional health of China's nationals has continued to improve, the problem of malnutrition still exists, and the incidence of nutrition-related chronic diseases, such as high blood pressure and hyperlipidemia, is also on the rise [3]. Advocating appropriate diets, promoting dietary health, and accurately assessing individual nutritional literacy have become topics of concern.

Nutritional literacy (NL) [4, 5] is a multidimensional concept that refers to an individual's ability to acquire, understand, process, and apply nutrition information and is usually classified as functional, interactive, and critical nutrition literacy. NL is the most basic, cost-effective, and practical measure to promote healthy nutrition, which is of great worth in promoting the nation's health [6]. Good nutritional literacy leads to good eating habits, improved dietary quality, healthier dietary choices, and improved nutritional status, and enables the prevention and control of nutrition-related non-communicable diseases [6–9].

With the widespread use of social media and electronic products, dietary and nutritional information is becoming more and more predominantly available through online media [10]. Several health organizations and individuals often post on social media on topics related to food, nutrition, and health [11]. These health messages from the mass media can have a significant impact on an individual's subjective health status [12]. However, social media content about health and nutrition may harm individuals' nutritional perceptions and food choices [13]. This requires users to look critically at nutritional information from various sources and to screen and judge the information.

With social media's popularity, the younger generation has become its primary user group. However, this group faces the dual challenges of declining diet quality and growing obesity in China. In particular, adults between 18 and 35 are seeing their dietary fat intake rise while their protein and carbohydrate intake decreases, and they are at risk of inadequate mineral intake [14]. These phenomena may be related to young people's dislike of home cooking, frequent breakfast skipping, and preference for fast food [15, 16]. Unhealthy lifestyles and diets in this group may not show immediate adverse effects on health but can increase the risk of chronic diseases [17]. Given this, it is particularly urgent to enhance the nutritional literacy of young people and improve their eating habits through nutrition education and management [18]. Before providing specialized nutritional care and education services to specific groups, it is crucial to have an in-depth understanding of their perceived level of nutritional literacy. This study aimed to culturally adapt the S-NutLit scale and explore the key factors influencing nutritional literacy. We expect that this study will allow us to more accurately assess the nutritional literacy of adults aged 18–35 and enhance their nutritional knowledge to promote the formation of healthy living habits.

Nutritional literacy levels affect people's health status. Understanding the causes of inadequate nutrient literacy is essential to reducing the burden of chronic non-communicable nutrition-related diseases [19]. We chose demographic variables as influencing factors to analyze to understand NL among young people.

Materials and methods

Participants and study design

The study was implemented using a convenience sampling method from December 2023 to March 2024. According to the definition of young adults in China's Medium-and Long-Term Youth Development Plan (2016–2025), we limited the age of participants to 18–35. Therefore, the main inclusion criteria for participants in this study were 18–35 and voluntary participation. According to the sample estimation method, the sample size should be 5–10 times the number of scale entries [20]. The sample size was calculated based on the 11 entries in the original S-NutLit scale. The sample size should be between 55 and 110 cases, plus 20% of invalid questionnaires; the inclusion sample should be 66 to 132 cases. A larger sample size is desirable for accuracy, so 508 young people were finally selected to participate in the questionnaire in this study.

Translation, counter-translation, and cross-cultural adaptation of the S-NutLit scale

The S-NutLit Scale was translated and adapted into English with the permission of Dr. Christophe Matthys [21]. The scale was translated using Brislin's Two-Way Translation method. First, two native Chinese-speaking college English teachers and graduate students majoring in English with study abroad experience translated the S-NutLit scale into Chinese. The initial Chinese translation was then retranslated into two English versions by two bilinguals without access to the original English questionnaire from linguistic and professional perspectives. The translated scale was then integrated and debugged by a nutritionist fluent in English with experience in related topics. Next, a committee of 5 experts was formed to conduct the cultural debugging, reviewing the questionnaire and judging the appropriateness of each question. These 5 experts included 2 nutritionists, 2 clinical nurse specialists, and 1 English professor. The criteria for selecting the experts were: (1) extensive expertise in nutrition or

nursing. (2) familiarity with the step-by-step and flow of tonal translation. (3) a graduate degree and work experience.

The original scale was revised, considering the opinions of experts and the current situation. Four points in the original scale were modified to make the scale entries more applicable to the Chinese youth population. Delete "fair trade coffee" from entry two as one of the examples of sustainable nutrition. This is because the meaning of "fair trade coffee" is unfamiliar to domestic consumers [22], and no examples of sustainable nutrition are particularly relevant to its meaning. In entry 3, the original scale, "Flemish Food Triangle," is a Belgian educational model depicting an inverted pyramid of dietary guidelines [21, 23]. It is similar in meaning and function to the Chinese balanced diet pagoda. Therefore, the "Flemish Food Triangle" was changed to "Chinese balanced diet pagoda." To simplify the formulation, replace "I can distinguish between reliable and less reliable websites" in entry 5 with "I can tell if a website is reliable." In Entry 7, to be more in line with the expression habits of Chinese people, change "I have the necessary skills to apply nutrition information when cooking." to "I can apply nutrition information when cooking." Fifty young people were invited to fill out a pre-survey questionnaire to assess the clarity and comprehensibility of the items after cultural adaptation of the above four parts of the original scale. The Chinese version of the S-NutLit Scale was developed after listening to the opinions and suggestions of all parties.

Questionnaire design

It consists of general information and the Chinese version of S-NutLit. The general information is self-designed for a total of 15 items, respectively: age, gender, BMI, ethnicity, marriage status, education level, occupation, usual place of residence, monthly income of the family, educational level of the father, academic level of the mother, whether or not they had taken a nutrition-related course, whether or not they had any chronic diseases such as diabetes, hypertension, and so on, how often they paid attention to nutritional information, and their self-assessment of their level of health. A detailed questionnaire can be found in Supplementary Material 1.

The S-NutLit scale

Dr. Jules Vrinten and colleagues developed the S-NutLit scale [21]. The scale has two dimensions: information skills and expert skills. It is scored on a Likert-type scale ranging from 1 to 5, with an additional" Additional answer option" for entry 7, which is not included in the total score. Higher scores indicate higher nutritional literacy among young people. The original scale was reliable and valid, with a Cronbach's alpha of 0.80.

Data collection

We used a convenience sampling method to recruit participants through an online survey service platform. The participants were mainly in China's Liaoning, Shandong, and Hunan provinces. The researcher explained the purpose of the survey to the participants, distributed the electronic version of the questionnaire, and informed them of the precautions to take when completing the questionnaire. After rigorous screening and sorting, 508 questionnaires were collected. Data were entered in pairs to ensure accuracy and completeness. Two weeks later, 50 survey respondents were randomly selected from the participants to assess the retest reliability of the scale.

Statistical analysis

Statistical description of general information was done through frequencies and percentages. Item analysis of the scale was performed using the correlation coefficient method and the critical ratio (CR). Validity analysis was conducted using content validity and structural validity. Internal consistency reliabilities and retest reliability ratings have been employed in reliability analysis. Categorical variables were subjected to independent samples t-test or one-way ANOVA. After screening for statistically significant variables ($P<0.05$), multiple linear regression was performed to screen for factors that could impact young people's nutritional literacy.

Item analysis

CR is an independent samples t-test for high grouping (highest 27%) and low grouping (lowest 27%) to assess the discriminant properties of the scale [24]. Entries with a critical ratio greater than three and statistically significant differences between the high and low subgroups were retained. Correlations between entries and overall scores were examined to assess the homogeneity of entries. Retaining entries with correlation values ≥ 0.4 [25].

Validity analysis

Content validity

Six experts in the fields of nutrition (3), nursing (1), public health (1), and psychology (1) were invited to form an expert committee to conduct the content validity analysis. All experts held intermediate or higher-level titles and had at least five years of work experience in their respective fields. They possessed solid professional skills and showed high motivation to participate in this study. The six experts assessed the scale using the Item-Level Content Validity Index (I-CVI) versus the Scale-Level Content Validity Index/Average (S-CVI/Ave). In general, the content validity of a scale is considered good when S-CVI/Ave ≥ 0.90 and I-CVI ≥ 0.78 [26].

Construct validity

After that, we randomly assigned the 508 samples to form two groups of the same size. The first group was used to conduct Exploratory Factor Analysis (EFA), and the second was used to conduct Factor Analysis (CFA). EFA was generally considered appropriate when the Kaiser-Meyer-Olkin (KMO) value was ≥0.6, and Bartlett's test of sphericity was $P<0.05$ [27]. EFA reflects how much a scale can measure a psychometric trait or a theoretically constructed construct [28]. The study used principal component analysis and maximum variance orthogonal rotation. The number of dimensions was determined using eigenvalues>1 and a scree plot [29]. Cumulative contributions greater than 50% were generally considered desirable [30], and items with factor loadings greater than 0.4 were retained [31]. CFA was used to explore the consistency of the EFA-constructed framework with the actual situation [32], and to evaluate the fit and applicability of the model using the comparative fit index (CFI>0.9), goodness-of-fit index (GFI>0.9), Tucker–Lewis Index (TLI>0.9), root mean square of the error of approximation (RMSEA<0.08), and chi-square degrees of freedom ratio (χ^2 /df≤3) [33–35]. Standardized factor loadings were used to calculate the average variance extracted (AVE) and CR values. The AVE values were used to assess the convergent validity of the model, and the CR values were used to determine its composite reliability. AVE greater than 0.36 was considered acceptable, more significant than 0.5 was considered desirable, and a CR value greater than 0.7 indicated that the scale had adequate internal consistency [36, 37]. Finally, the discriminant validity of the model was judged using the heterotrait-monotrait ratio (HTMT). The model has good discriminant validity if HTMT is less than 0.85 [38].

Reliability analysis

Reliability tests were evaluated using Cronbach's alpha coefficient and retest reliability. Homogeneity and intrinsic correlation between the items of the Chinese version of the S-NutLit scale were assessed using Cronbach's alpha coefficient, which was at least 0.7 [39]. Two weeks later, a sample of 50 cases was randomly selected from the previous participants for repeated measurements. The interclass correlation coefficient (ICC) was calculated, and an ICC>0.7 indicated good scale stability [40].

Results

Descriptive statistics

A total of 508 participants were recruited for analysis in this study. Among them, 308 (60.6%) were 18–25 years old, 293 (57.7%) were female; BMI was in the normal range in a total of 342 (67.3%), and unmarried was 340 (66.9%) in marital status. Table 1 shows the specific general information data. The skewness and kurtosis values are between −2 and 2, consistent with a normal distribution. (See Table 2).

Item analysis

In this study, the S-NutLit scale had 11 entries with scores between 10 and 55, with scores≤32 for low grouping and ≥39 for high grouping. The CR ranged from 10.070 to 18.545, with good differentiation. The correlation coefficients between the entries and the overall scale score ranged from 0.443 to 0.664, which suggests that the individual entries correlate with the scale as a whole. The Cronbach's alpha of the scale was not exceeded after deleting the entries (Cronbach's alpha=0.826; Table 3).

Validity analysis

Content validity analysis

The results of the content validity measures by the six specialists were I-CVI between 0.833 and 1.000 and S-CVI of 0.908. The content validity was reasonable and within the acceptable range.

Exploratory factor analysis

Structural validity was analyzed using two dimensions and 11 entries of the original scale, with a scale KMO value of 0.857 and Bartlett's test of sphericity of 768.620 ($p<0.001$). This indicates that exploratory factor analysis can be continued next. In Fig. 1, the downward trend slows down after the 3rd point, so the two factors in the original scale are desirable. The cumulative variance contribution is 51.029%. Otherwise, loads of the coefficients are within the normal range, as shown in Table 4.

Validation factor analysis

The validation factor analysis showed that the model had CFI=0.964, GFI=0.950, TLI=0.954, RMSEA=0.053, and χ^2/df=1.720. The model was generally well-fitted, and the model fit data were ideal. Consistent with the original scale, the translated S-NutLit scale has two dimensions, information skills and expert skills, and 11 entries. (**See** Fig. 2).

Convergent validity and discriminant validity

The AVE values for the two dimensions of the model are 0.420 and 0.515, greater than 0.36, and the composite reliability values are 0.852 and 0.760, greater than 0.7. These indicate that the model has good convergent validity and composite reliability. The HTMT value is 0.515, less than 0.85, indicating the model has good discriminant validity (Table 5).

Reliability analysis

The Cronbach's alpha coefficient for the total scale was 0.826, and the Cronbach's alpha coefficients for the two dimensions were 0.825 and 0.732, indicating that the

Table 1 Frequency distribution of general information characteristics and one-way analysis of factors influencing nutritional literacy among young people ($n = 508$)

Factors	*N*	%	t /F	*p*-value	Bonferroni
Age			-0.570	0.569	
18–25	308	60.6			
26–35	200	39.4			
Gender			-0.485	0.628	
Male	215	42.3			
Female	293	57.7			
BMI			2.427	0.065	
Thin	85	16.7			
Normal weight	342	67.3			
Overweight	52	10.2			
Obese	29	5.7			
Ethnicity			0.606	0.545	
Han	487	95.9			
Minority	21	4.1			
Marital status			0.088	0.916	
Unmarried	340	66.9			
Married	157	30.9			
Others	11	2.2			
Education level			3.750	0.011	
Middle school and below①	20	3.9			①④*
High School or Junior College②	108	21.3			②④*
Undergraduate or specialized③	313	61.6			③④*
Postgraduate student④	67	13.2			
Career			1.633	0.165	
Students	276	54.3			
Agency/institution employees	53	10.4			
Enterprise staff	76	15.0			
Self-employed and freelancers	93	18.3			
Else	10	2.0			
Permanent residence			1.751	0.081	
Rural	159	31.3			
Municipalities	349	68.7			
Monthly household income (CNY)			5.155	0.002	
≤ 3000①	60	11.8			①④*
3000 ~ 5000②	142	28.0			②④*
5001 ~ 10,000③	185	36.4			③④*
≥ 10,001④	121	23.8			
Father's education			9.188	0.001	
Middle school and below①	240	47.2			①③*
High School or Junior College②	167	32.9			①④*
Undergraduate or specialized③	89	17.5			②③*
Postgraduate student④	12	2.4			②④*
Mother's education			13.790	0.000	
Middle school and below①	280	54.9			①③*
High School or Junior College②	144	28.3			①④*
Undergraduate or specialized③	76	15.2			①③*
Postgraduate student④	8	1.6			②④*
					③④*
Whether or not you have taken a nutrition-related course			5.143	0.000	
Yes	140	27.6			
No	368	72.4			
Diabetes, hypertension, and other chronic disease			11.991	0.803	
Yes	35	6.9			

Table 1 (continued)

Factors	*N*	%	t /F	*p*-value	Bonferroni
No	473	93.1			
Frequency of Nutrition Information			8.758	0.000	
Never①	9	1.8			①④* ①⑤*
Occasionally②	156	30.7			②④* ②⑤*
Sometimes③	155	30.5			②④* ③⑤*
Often④	165	32.5			
Always⑤	23	4.5			
Self-assessed health level			1.971	0.140	
Poor①	21	4.1			
Genera②	196	38.6			
Better③	291	57.3			

Table 2 Scores for scale entries and total scores

Classification	Item score	Skewness	kurtosis
1. If I have questions about healthy nutrition, I know where I can find information about it.	3.53 ± 0.902	-0.993	0.524
2. If I have questions about sustainable nutrition, I know where I can find information about it. Examples of sustainable nutrition are organic vegetables, free-range eggs, etc.	3.53 ± 0.936	-0.707	-0.034
3. I am familiar with the basic rules of the Chinese balance Dietary Pagoda.	3.25 ± 1.110	-0.106	-0.924
4. I can assess whether information about nutrition is written with the intention of making money, for example by people who want to sell a product.	3.45 ± 1.016	-0.415	-0.520
5. When I search for information about nutrition on the internet, I can judge whether websites are reliable or not.	3.46 ± 0.975	-0.522	-0.280
6. Advertisements often link nutrition and health. I find it easy to judge whether these links are correct or not.	3.37 ± 0.975	-0.427	-0.649
7. I can apply the nutrition information I know when cooking. (Additional answer option: "I never cook").	3.37 ± 0.975	-0.996	0.059
8. I can assess whether information about nutrition in the media is reliable.	3.27 ± 0.975	-0.228	1.099
9. I discuss information about nutrition with experts.	2.02 ± 0.986	0.857	0.190
10. I follow nutritional advice from experts	2.95 ± 0.986	-0.399	-0.082
11. I base my diet on the latest scientific knowledge	3.12 ± 0.903	-0.062	-0.283
Dimension 1	27.23 ± 5.671	-0.766	0.655
Dimension 2	8.06 ± 2.291	0.162	0.024
Score	35.31 ± 6.815	-0.519	0.592

Table 3 Item analysis for the Chinese version of the S-NutLit scale

Item	CR	The correlation between the item and the total score	Cronbach's alpha, if an item deleted
1	12.833	0.608	0.810
2	15.392	0.654	0.806
3	15.732	0.644	0.808
4	15.280	0.627	0.809
5	15.850	0.671	0.804
6	16.536	0.663	0.805
7	18.545	0.659	0.817
8	13.498	0.657	0.807
9	10.276	0.457	0.825
10	10.070	0.497	0.821
11	12.396	0.574	0.814

scale's and the dimensions' reliability was good. The scale's retest reliability was calculated in 50 randomly selected cases among the participants. The results showed that the retest reliability of this scale was 0.818, and the scale was stable for repeatable measurement.

Single-factor analysis of Young people's nutritional literacy

The results of the univariate analysis of variance showed statistically significant differences in young people's nutritional literacy by level of education, monthly family income, father's educational level, mother's educational level, whether or not they had taken a nutrition-related course, and how often they paid attention to nutritional and health information ($P<0.05$). The Bonferroni test further examined them, as shown in Table 1.

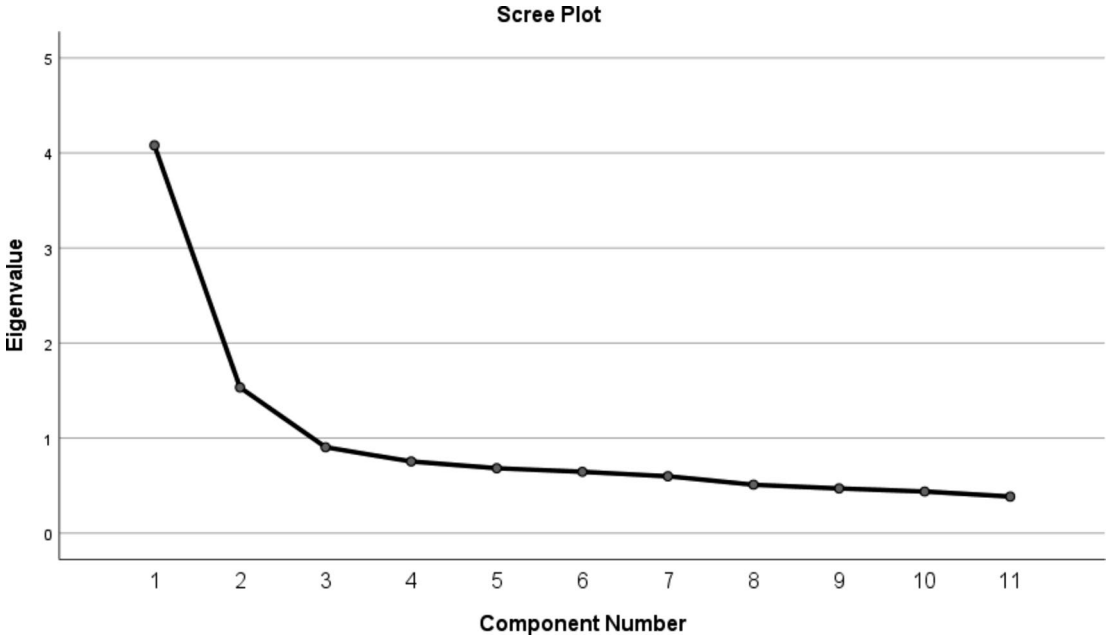

Fig. 1 Scree plot of exploratory factor analysis for the Chinese version of S-NutLit

Table 4 Factor loadings of exploratory factor analysis for the Chinese version of the S-NutLit scale

Item	Factor 1	Factor2
1	0.700	
2	0.718	
3	0.612	
4	0.639	
5	0.716	
6	0.654	
7	0.539	
8	0.667	0.306
9		0.777
10		0.784
11		0.763

Table 5 Convergent validity and discriminant validity of the Chinese version of the S-NutLit

Item			Standardized Factor Load	Composite Reliability	AVE	HTMT
1	<---	F1	0.688	0.852	0.420	0.515
2	<---	F1	0.701			
3	<---	F1	0.615			
4	<---	F1	0.641			
5	<---	F1	0.687			
6	<---	F1	0.636			
7	<---	F1	0.586			
8	<---	F1	0.619			
9	<---	F2	0.649	0.760	0.515	
10	<---	F2	0.769			
11	<---	F2	0.730			

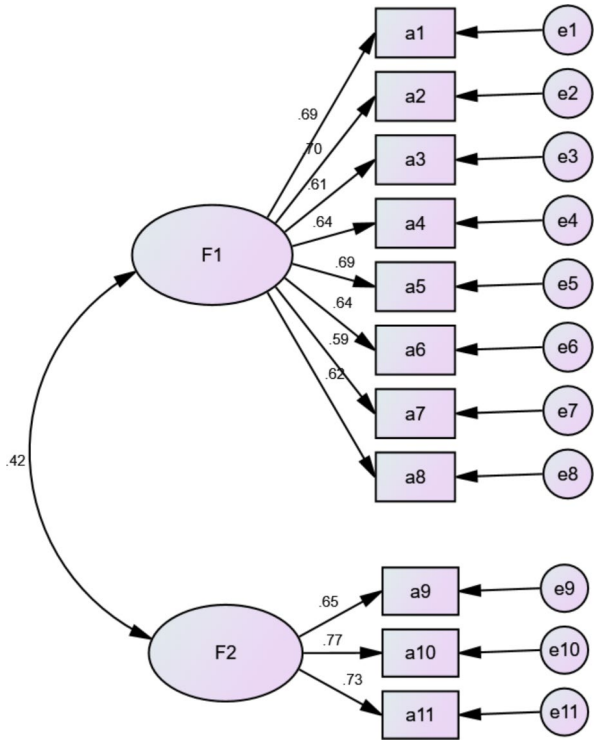

Fig. 2 Standardized 2-factor structural model of the S-NutLit ($n = 254$)

Multiple linear regression analysis of young people's nutritional literacy

Multiple stepwise linear regression analyses showed that the level of education, the mother's education, whether or not they had received nutrition-related courses, and the frequency of attention to nutritional information were

potential influences on S-NutLit. The variance inflation factor (VIF) of all variables in the covariance diagnostic was less than 5, indicating no multicollinearity among the variables. (**See** Table 6).

Discussion

Malnutrition remains prominent in China, and to enhance dynamic monitoring of nutritional characteristics and develop effective nutritional improvement strategies at the individual level [41]. In this study, the S-NutLit was linguistically translated and culturally adapted to assess the psychometric properties of a sample of young adults and to analyze the factors influencing young people's nutritional literacy. The translated edition of S-NutLit has the same number of items and factor construction as the original English version, with two dimensions (information skills and expert skills) and 11 entries [21]. The scale was used for the first time in a Chinese population with excellent validity and reliability. It can accurately evaluate the nutritional literacy of adolescents and provide support for nutritional monitoring.

When we compared the debugged back-translated version with the original version, we found some differences between the two versions. These differences are found in entries 5 and 7 and are mainly related to the language's unique grammatical and syntactic rules. When discrepancies are found, the back-translator provides the translator with a detailed explanation of the differences between the two versions. Based on the discussion, the translator modifies the discrepant items. The back-translator then translates the modifications from Chinese to English. This process was continued until the scale items in the two English versions had the same meaning. In addition, we found that domestic consumers are unfamiliar with the concept of "fair trade coffee" [22], so we tried to replace it with a similar idea to avoid unnecessary trouble caused by direct translation. However, we have not yet found a concept that can fully replace "fair trade coffee" and reflect the principles of sustainable nutrition. As an example of sustainable nutrition in Entry 2, its removal would have a lesser impact. So, to minimize inaccurate scoring due to comprehension bias, the experts recommended removing this example from the scale. Such an adjustment would ensure the scale's accuracy and applicability while maintaining the fluency of the assessment process and respondent participation. When a participant selected the "additional answer option" for entry 7, it indicated that this participant did not apply to entry 7. Very few participants (9.8%) in our study selected the "additional answer option". In all subsequent exploratory and validation factor analyses, we treated this response as a missing value and did not include it in the analyses [42].

The Chinese version of the S-NutLit scale has an S-CVI of 0.955 and an I-CVI of 0.833 to 1.00, both greater than 0.8. The content covered by the scale can reflect the concept of NL. Consistent with the original scale, two male factors were extracted, and the cumulative variance contribution based on the two factors in this study was 51.029%. This result suggests that the individual entries in the scale have good explanatory power for interpreting young people's NL. The fitted data in the validated factor analysis were ideal and had good construct validity. Cronbach's alpha coefficients enable the evaluation of scale quality [43]. The Cronbach's alpha coefficient of the Chinese version of the S-NutLit scale is 0.826, the Cronbach's alpha coefficient of the original scale is 0.80, and the dimensions of "information skills" and "expert skills" are 0.83 and 0.79, indicating that the S-NutLit has a high internal reliability. The AVE for the "information skills" dimension is 0.420, related to the additional answer option in entry 7. Its presence impacted the scale's validity, which was still acceptable despite the low AVE value. Retest reliability was conducted after two weeks, and the result of the retest reliability in this study was 0.818, while the retest reliability of the original scale was 0.74. The Chinese version of the S-NutLit has higher retest reliability, indicating that it can reliably and stably measure young adults' nutritional literacy. In short, the Chinese version of the S-NutLit scale can effectively measure NL in young adults and be further applied in future clinical practice.

The mean score±standard deviation of nutritional literacy in this study was 35.31±6.815, which puts the

Table 6 Multilinear regression modeling of S-NutLit overall scores

	B	β	t	*P*	95% CI	Collinearity statistics	
						Tolerance	VIF
Constant	28.640		13.787	< 0.001	[24.559,32.721]		
Education level	1.268	0.129	3.053	0.002	[0.452,2.083]	0.941	1.063
Father's education	0.100	0.012	0.181	0.856	[-0.981,1.180]	0.380	2.630
Mother's education	1.438	0.167	2.562	0.011	[0.335,2.540]	0.396	2.524
Monthly household income	0.435	0.061	1.379	0.168	[-0.184,1.054]	0.862	1.160
Whether or not you have taken a nutrition-related course	-2.514	-0.165	-3.904	< 0.001	[-3.779, -1.249]	0.944	1.059
Focus on Nutritional health information frequency	1.209	0.166	3.905	< 0.001	[0.600,1.817]	0.929	1.077

nutritional literacy of young Chinese adults at an intermediate level. The findings are consistent with those of two earlier studies conducted in China [44, 45], suggesting that the nutritional literacy of young people still needs to be further improved. The results of this study show that young people's level of education, whether or not they had taken a nutrition-related course, their mother's level of education, and the frequency of attention to nutritional health information entered the regression equation. These four variables are suggested to be factors affecting young people's nutritional literacy.

The present study found that the level of education was related to the nutritional literacy of individuals and that there was a significant difference in nutritional literacy between young people's postgraduate qualifications and other levels of education. Similar conclusions have been made in other research, concluding that people with more education will perform better regarding eating behaviors [45] and that low education is a barrier to nutritional literacy [46]. Educational level predicts disease risk, health behavior patterns, and diet quantity more accurately than other socioeconomic factors [10]. This may be because individuals at higher education levels have a higher capacity to acquire knowledge and skills and are better able to understand, process, and apply the nutrition information acquired [47, 48]. Higher-educated people are more likely to have access to knowledge and data regarding diet and wellness [10]. In China, mothers are primarily responsible for taking care of and educating their children and devoting more energy and time to family life, significantly influencing their words and actions in daily life. Mothers with higher levels of education generally have more significant health awareness and nutritional knowledge, which they are more likely to pass on to their children, thereby increasing their children's understanding and ability to improve their health [49–51].

Nutritional literacy is essential in food education programs that promote healthy eating habits and general health in individuals [52]. The results of this study are consistent with previous studies, which suggest that nutrition education can be effective in improving individuals' nutritional literacy levels [48]. Nutrition knowledge and literacy levels are interrelated and positively correlated [19, 53], and school-based nutrition education can enhance students' nutrition knowledge and skills [54]. Nutritional knowledge influences individuals' perceptions and choices of food and can motivate individuals to choose foods of excellent nutritional value [6]. To improve individuals' nutritional literacy, nutritional courses in schools and online instructional videos posted through official social media accounts are necessary. These videos can guide young people in learning about nutrition and applying it to their daily diets [55]. In this study, the frequency of searching and browsing for nutritional health information was related to an individual's nutritional literacy. When individuals pay frequent attention to nutritional health information, such as "often" or "always", their nutritional literacy tends to differ significantly from those who pay less attention to such information. Literacy is a gradual process, and individuals who pay regular attention to nutrition and health information have a wealth of nutritional knowledge and a better understanding of nutritional concepts and the impact of food choices on health [56]. Being updated on nutritional knowledge can motivate individuals to adjust their unscientific eating habits and adopt more scientific food choices. Encouraging and facilitating young people to pay regular attention to nutritional health information is an effective way to improve nutritional literacy.

Although several existing commonly used scales play an essential role in assessment and research, they inevitably have some limitations. The Nutrition Literacy Assessment Instrument (NLAI) does not measure the ability to critically view nutrition literacy and apply nutrition knowledge [57]. The Nutritional Literacy Scale (NLS) primarily assesses the respondent's understanding of nutritional information [58]. The Chinese Health Literacy Scale for Low Salt Consumption - Hong Kong population (CHLSalt-HK) assesses health literacy related to low salt intake using older adults as the target population [59]. The Nutrition Literacy Measurement Scale for Chinese Adults (NLMSC) is primarily intended for the adult public [60]. However, nutritional literacy can be significantly affected by multiple factors such as social environment and economic conditions, and there may be significant differences in these aspects among individuals of different ages, which makes the scale lack a certain degree of relevance and adaptability in its application. The S-NutLit Scale contains entries on three levels: functional, interactive, and critical, which are used to identify and assess nutritional literacy comprehensively. It is designed to determine the nutritional literacy of young people and is more relevant than other scales. The scale is concise and has good reliability and validity, which provides healthcare professionals with a more convenient and accurate tool to assess the nutritional literacy of young people.

Limitations

Convenience sampling, which is convenient, flexible, and cost-effective, was used in this study. However, the arbitrariness of convenience sampling in determining the sample may lead to selection bias. In this study, this bias was mainly reflected in the distribution of occupational categories, with a high proportion of student respondents, totaling 276 or 54.3% of the total respondents. This may result in a less representative sample. With the popularisation and lengthening of tertiary education in

China and the increasing concept of lifelong learning, young people's graduation age tends to increase. The data for our study comes primarily from an online service platform with a large student user base. Therefore, even with the best efforts to reach young people from different fields and backgrounds, our research sample still tends to reflect the views of the student population to some extent. For practical reasons, investing more effort in recruiting young people from other occupations was impossible. To mitigate this limitation in future studies, we recommend using a stratified sampling method, whereby young people are stratified according to their occupational characteristics, and a random sample is drawn from each stratum. In addition, increasing the sample size is one of the effective strategies to reduce the impact of bias. This study mainly includes individual factors such as gender and age and family factors such as parent's education level. However, social factors such as government nutrition policies and community nutrition awareness also impact individual nutritional literacy. In the future, social-ecological systems theory can be applied to explore how individual nutritional literacy is affected by multiple factors, such as the individual, the family, and the community. Based on this, dietary interventions can be designed and implemented more comprehensively to promote the nutritional health of individuals and communities.

Conclusion

The Chinese version of the S-NutLit Scale contains 11 entries and two dimensions with satisfactory reliability and validity. The adapted and validated S-NutLit scale is more suitable for Chinese people, and its applicability in other countries can be further explored. The low level of education of individuals and their mothers, the lack of experience in nutrition-related courses, and the infrequent attention to nutritional health information have made some young people vulnerable to low dietary literacy. More attention should be given to nutritional health issues among this group of young people. By applying the Chinese version of the S-NutLit Scale, we can more conveniently and accurately assess individuals' nutritional literacy levels. This, in turn, supports the formulation of targeted nutrition education programs and public health policies. It also helps us more effectively identify high-risk groups and provide them with the necessary support and intervention, thus promoting the nutritional health level of the whole society.

Abbreviations

AVE	Average variance extracted
CFA	Confirmatory factor analysis
CFI	Comparative fit index
CR	Critical ratio
EFA	Exploratory factor analysis
GFI	Goodness-of-fit index
ICC	Interclass correlation coefficient
I-CVI	Item-Level Content Validity Index
HTMT	Herterotrait-monotrait ratio
KMO	Kaiser-Meyer-Olkin
NL	Nutritional literacy
RMSEA	Root mean square of the error of approximation
S-CVI/Ave	Scale-Level Content Validity Index/Average
S-NutLit	Short Nutrition Literacy Scale
TLI	Tucker–Lewis Index
χ^2/df	Chi-square degrees of freedom ratio

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Author contributions

YL, LZ, KX, YD, FL, and TZ were involved in the study route design and data collection. YD, FL, and TZ collected and statistically analyzed the data. YL wrote the draft. LZ and KX revised the draft as necessary to identify important intellectual content. All authors contributed to the article and approved the submitted version.

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Data availability

The datasets used and analysed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

The protocol of this study was reviewed and approved by the Ethics Committee of Jinzhou Medical University (no. JZMULL2023184). Written informed consent was obtained from each participating individual for this study.

Competing interests

The authors declare no competing interests.

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