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A new health literacy scale for staff in preschool childcare institution: development and preliminary validation

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Abstract

Background The health literacy of staff in preschool childcare institution is an important issue to consider in providing healthcare for children aged 3–6 years, which could contribute to reducing incidence of diseases and accidental injuries as well as maintaining children's good health. Seldom instruments have been designed to measure health literacy across this group. This research aims to develop a health literacy scale for staff in preschool childcare institutions and validate its psychometric properties.

Methods The scale was developed through four phases. In Phase 1, an item pool was developed mainly based on literature review and kindergarten work; In Phase 2, the initial items were reviewed by fifteen experts and content validity analysis was conducted; In Phase 3, a pilot study was conducted involving 30 kindergarten staff, which aimed to further modify the scale; In Phase 4, a psychometric validation study involving 466 kindergarten staff was conducted through a cross-sectional survey in May 2023. Item analysis was performed through critical ration, correlation analysis, and Cronbach's alpha if item deleted. Construct validity was performed through exploratory ($n=190$) and confirmatory factor analyses ($n=276$). Convergent and discriminant validity were evaluated. Reliability was evaluated through internal consistency, split-half reliability, and test-retest reliability.

Results The final Health Literacy Scale consisted of 28 items, including dimensions of Basic Health Knowledge (11 items), Functional Health Literacy Skills (3 items), Communicative Health Literacy (5 items), and Critical Health Literacy (9 items). Principal component analysis revealed a four-factor structure that explained 80.092% of the total variance. The goodness-of-fit indices signified an adequate model fit ($\chi^2/df=2.093$, RMSEA = 0.063, RMR = 0.031, GFI = 0.852, CFI = 0.958, NFI = 0.923, IFI = 0.958, TLI = 0.953, PCFI = 0.844). Cronbach's alpha showed a good internal consistency reaching a value of 0.921. The split-half reliability was 0.805, and the test-retest reliability was good with an intraclass correlation coefficient of 0.885 ($P<0.001$).

Conclusions The Health Literacy Scale developed in this research focuses on health literacy issues related to children aged 3–6 years. The scale is demonstrated to be valid and reliable for assessing the health literacy of staff in preschool childcare institutions. It could potentially be used as an effective instrument for targeted development of health literacy intervention.

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Keywords Preschool, Health literacy, Scale development, Reliability, Validity

Background

Children aged 3–6 years are prone to suffer some health problems, such as, anemia, obesity, psychological and behavioral abnormalities, poor eyesight, dental caries, and infectious diseases, etc [1, 2]. Inappropriate caring practices have adverse effects on children's healthy growth and development [3]. In China, children aged 3–6 years are referred to as preschool children. A preschool or kindergarten is a childcare and educational institution that specifically caters to children aged 3–6 years [4]. The proportion of children of appropriate age enrolled in kindergartens was 83.4% by 2019, with a further increase of 32.5% projected in the past decade [5]. According to the data from the National Bureau of Statistics of China, as of 2022, there were more than 289,200 kindergartens in China. Kindergarten staff includes teachers, caregivers (also called childcare workers), healthcare personnel, kindergarten principals and administrators and they are responsible for monitoring, managing, and making decisions on children's health issues. They are often the primary people who care for children aged 3–6 years outside home environment and they have a significant impact on children's health behaviors and health outcomes [1]. Studies [6, 7] have demonstrated that in a kindergarten setting, staff with limited knowledge of children's health and health-related skills may have difficulties in comprehending important aspects of handling common emergencies, preventing diseases, and performing health and safety checks for children. Their prior health knowledge and behaviors have a profound impact on health knowledge, health behaviors, and future healthy lifestyles of preschool children [8, 9].

Health literacy concerns the knowledge and competencies of individuals to cope with complex health problems and meet individual health demands in modern society [10, 11]. It has been increasingly valued in the field of clinical medicine and public health. Relevant studies have been gradually extended from whole society to subgroups. The Chinese Government has attempted to combine the area of healthcare and education in recent years, and has been providing long-term support for programs focused on health promotion, health education, and the development of health literacy in kindergarten environment. The regional governments also attach great importance to the healthcare of kindergarten children and have actively explored the new model of "combining healthcare with education" [12]. The kindergarten staff are required to receive regular vocational training or/and professional training from healthcare experts before and after their employment, including but not limited to the related lectures on physiological and psychological health knowledge, and first aid knowledge and skills about preschool children. As far as teachers majoring in preschool education are concerned, they have received education and training on health and hygiene-related knowledge so that they are basically competent in providing relevant education for children [2]. For teaching and non-teaching staff in the kindergarten, they play several roles and make concerted effort to provide better healthcare for preschool children [13], including first aid, designing initiatives to help children form healthy habits, recognizing health problems, and allocating children to suitable prevention schemes [14]. Therefore, it is important to recognize that teaching and non-teaching staff in the kindergarten are all responsible for preschool children's health and its improvement. Low health literacy could negatively affect personal abilities to use health-related information for prevention and intervention of children's physical and psychological problems, ultimately impacting health outcomes and health costs in society [15, 16].

Additionally, kindergarten staff plays an important role in implementing health and behavior interventions [17]. Health literacy is crucial for successful implementation of intervention to understand children's perspectives of health management and modify health behavior in preschool children on the part of educators [18, 19]. Kindergarten staff should have the ability to identify and intervene in children's health conditions, be able to obtain health information, critically analyze and use this information to make decisions to control children's health conditions [20]. Empowering staff through training and skills development can therefore capacitate them to introduce health promotion in early childhood [21]. It is necessary to provide staff in the kindergarten with training and support in developing health literacy, and then to deliver health promotion programs effectively. Assessing the health literacy of staff in the kindergarten allows for a more sophisticated analysis of the determinants and consequences of lower health literacy, providing a foundation for evaluating interventions to improve their health literacy.

The health literacy assessment tools that purport to measure health literacy have been developed in diverse approaches and populations. Test of Functional Health Literacy in Adults (TOFHLA) [22], Rapid Estimate of Adult Literacy in Medicine (REALM) [23], and Newest Vital Sign (NVS) [24] are mainly used to measure reading comprehension or numerical ability in a medical context. Other instruments are designed including specific health contents, such as the Food and Nutrition Literacy Questionnaire (FNLQ) [25], the Toddler Feeding Questionnaire (TFQ) [26], the Questionnaire Towards Knowledge,

Attitude, Practice of First Aid [27], which may be insufficient to evaluate communicative and critical health literacy. Multidimensional assessment tools have been developed, such as, the European Health Literacy Survey Questionnaire (HLS-EU-Q) [28], the Health Literacy Questionnaire (HLQ) [29], the 14-item Health Literacy Scale (HLS-14) [30]. However, they are designed for general populations and most of them mainly address issues pertinent to adult life. They do not cover the uniqueness of competencies required to care for preschool children and may have limited capacity to assess the health literacy of kindergarten staff. According to relevant studies [20, 31], in terms of health literacy in the kindergarten environment, kindergarten teaching and non-teaching staff are required to have the ability to apply health information to enhance children's awareness of learning of health concepts and skills in addition to the capacity to obtain, understand and interpret children's basic health information in the aspect of practical health education or healthcare activities. Given that the current health literacy instruments have their limitations, this research aims to develop and validate a new health literacy scale for staff in preschool childcare institutions.

Methods

The development of scale was performed by referring to a clear and practical guideline [32]. The guideline outlined a thorough process from the beginning phases of scale development to the validation of constructed scales. In this research, the Health Literacy Scale for staff in preschool childcare institution was developed by the following four phases: In Phase 1, determined what was to be measured, generated an item pool by literature search and interviewing, and determined item format; In Phase 2, expert consultation was conducted to review the initial items, evaluated content validity, and modified the items according to experts' suggestions; In Phase 3, a pilot survey was conducted among a small sample; In Phase 4, the analyses of validity and reliability of the scale was made to further modify and determine the internal factor structure of the scale. Figure 1 displayed four phases and different methods used in each phase.

Theoretical framework

The theoretical framework used to conceptualize the health literacy of staff in preschool childcare institution was based on Nutbeam's framework [33, 34], which defines health literacy as three domains including functional health literacy, interactive/communicative health literacy, and critical health literacy. These three domains

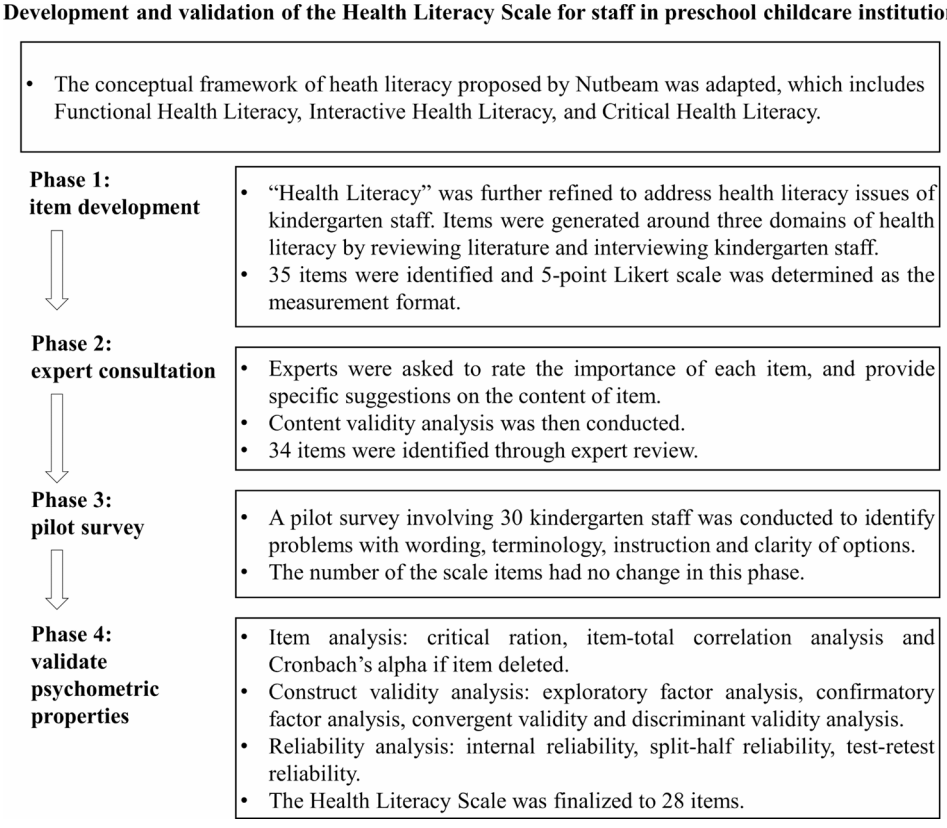

Fig. 1 Diagram for the procedures followed to develop the scale

of health literacy were used as a theoretical foundation in this research, namely, functional, communicative, and critical health literacy. The above constructs were further refined to address health literacy issues of kindergarten staff. Experts were purposively selected by the research team for their expertise in preschool healthcare and health education. They provided recommendations on the connotations of each domain based on Nutbeam's conceptual framework of health literacy, and they were also invited to review the initial items.

In the context of measuring kindergarten staff's health literacy, functional health literacy refers to possessing basic skills in reading, writing, and numeracy required to obtain health information, as well as knowledge of health risks in preschool children. Communicative health literacy in this context refers to more advanced cognitive and literacy skills, as well as social skills, which determine the ability to extract health information and apply new information appropriately to change circumstances. This type of health literacy enables kindergarten staff both to act independently according to new information and to interact with greater confidence with preschool children, and thus help them to change unhealthy behaviors. Critical health literacy describes more advanced cognitive skills and social skills, which can be applied to critically analyzing health information, and then uses this information to exert great control over health issues of preschool children. As this framework possesses a comprehensive interpretation of the definition and connotations of health literacy, it is applicable for determining the dimensions of the Health Literacy Scale in this research.

Item development

Combined with kindergarten work, the item pool was generated around three domains of health literacy by reviewing relevant literature including guidelines, and finally confirmed based on the suggestions from kindergarten staff and group discussions.

The following databases were searched from their inception to August 2022: Web of Science, PubMed, Medline, China National Knowledge Infrastructure (CNKI), and Wan Fang Data. The research terms were: (health literacy OR literacy OR competenc*) AND (preschool OR children) AND (scale OR questionnaire OR measure* OR assess* OR evaluat*). This research also adopted the developed health literacy instruments tailored to the general population as a reference to enrich the contents of item, such as, the Health Literacy Monitoring Questionnaire for National Residents [35], the 14-item Health Literacy Scale [30], etc. The Chinese Government has released "The Guidelines for Learning and Development of Children Aged 3–6 Years", which recommends the best practice of childcare, and the "Health Literacy of Citizens Knowledge and Skills (66 contents)". The items were generated based on the above official documents. Then, the interviews were conducted with kindergarten staff, including kindergarten principals, teachers and caregivers. The interview questions included common health issues of preschool children and the strategies of obtaining health information. Feedback on the draft items were subsequently collected from kindergarten staff. Four items were modified to emphasize the most important aspect of healthcare activities in the kindergarten. Finally, through group discussions with members of research team, item pool was further determined. The team members were composed of a professor with over twenty years of extensive experience in child healthcare and nursing research, and four PhD and Master candidates including both full-time and on-the-job students from the School of Nursing in domestic universities. Additionally, a vice professor from the School of Early Childhood Education in a domestic university also contributed to the discussions. The team members specialized in their research areas, such as, children's health and nursing, intelligent health monitoring for young children, and early childhood care and education. They all had experience in scale development and adaptation, providing valuable insights into the content and structure of the scale based on their individual academic background, which ensured the rationality and applicability of the items. Through group discussions, the refined item pool consisting of 35 items was developed after making appropriate modifications, and the measurement format was categorized into five-point Likert scale.

Thirteen items were identified as "Functional Health Literacy" including basic literacy skills and preschool health knowledge regarding nutrition and growth, vaccination, physical activities, injuries, and disease. Twelve items were identified as "Communicative Health Literacy" including acquiring and applying information, interacting with children to teach healthy behaviors, communicating with parents and health professionals, confidence in applying new information. Ten items were identified as "Critical Health Literacy" including critically analyzing information and exerting control over situations and events regarding preschool children's health.

Expert consultation

A panel of experts which comprised fifteen experts specializing in early childhood healthcare and education was established. The characteristics of experts were as follows: working in his/her field for over 10 years, familiarity with providing children healthcare or health education, and holding an intermediate or higher professional title.

The experts were invited to participate in an e-mail consultation from October to November 2022. They were asked to confirm whether the chosen items can represent

the actual situations encountered by kindergarten staff and whether each item can clearly describe the actual situation. The importance of each item was scored by using a five-point Likert scale (1 = "not important", 2 = "less important", 3 = "quite important", 4 = "very important" to 5 = "extremely important"). Several items were revised repeatedly based on expert recommendations and repeated discussions within the research group. A scale with 34 items was finally identified in this phase.

Pilot survey

A pilot test was conducted in January 2023 while kindergarten staff were recruited with the same criteria as those who have participated in the phase of validation study. The scale comprised of 34 items was pilot-tested with a small convenient sample. Thirty preschool teachers and caregivers participated in the pilot survey, aiming to detect problems with wording, terminology, instruction, and clarity of options, making sure that the scale items were readable. In the prior version, the item "I know the preventive measures for vitamin/micro-nutrient element deficiencies in preschool children" was revised to be the item "I know the nutritional requirements for preschool children" according to the suggestions provided by preschool teachers. The manifestations of zinc deficiency, iron deficiency, and iodine deficiency which needs to be judged combined with many factors, and the micro-elements test were not within the scope of routine examinations in the kindergarten. The complex terms were avoided in the revised scale, and the measuring format of the 5-point Likert Scale was acceptable. After the pilot survey, there was no change in the number of scale item. The completion time of the scale was 5–10 minutes.

The psychometric properties of scale

Design and participants

A cross-sectional study was conducted in 30 kindergartens by using convenience sampling from seven cities in a province of southeast China in May 2023. This province was selected because it covers kindergartens in areas with different economic levels, such as rural, town, and city. It also covers different nature of kindergartens, such as public kindergarten (which are subsidized or supported by the government), private kindergartens (which are organized by social non-profit organizations or profit organizations). And they are accessible to the investigators. Kindergarten caregivers and teachers who were responsible for children aged 3–6 years, healthcare personnel (such as, healthcare physicians, nurses, or related health support personnel), kindergarten principals and administrators who were involved in health activities or managed healthcare affairs of kindergarten children, were the targeted population in this research. The inclusion criteria for participants were as follows: (a) the staff aged ≥ 18 years; (b) having the ability to communicate and write; (c) being willing to participate in this research. Kindergarten staff who had days off due to severe illness, and those who were rarely involved in healthcare activities of children aged 3–6 years, were excluded. The sample size for exploratory factor analysis was determined by at least 5 times the size of the item of scale with a sample loss rate of 10%, at least 200 study subjects were planned to be included in the confirmatory factor analysis [36]. A total of 482 kindergarten staff were invited to complete the initial scale, 11 participants did not respond to the invitation, and 5 invalid questionnaires were removed due to straight-lining or non-differentiation answers. The age of the participants ranged between 18 and 58 years. Most of them were women (n=449). Almost half of the participants had a bachelor's degree or higher (n=195).

Data collection

An electronic report (e-poster) with a quick response code (QR code) was generated after creating an online questionnaire through Sojump (http://www.sojump.com). We kept in touch with kindergarten administrators to identify eligible participants. An Invitation to participate and a detailed explanation were posted in their WeChat Working Group, allowing kindergarten staff to voluntarily participate in this survey. Health Literacy Scale and General Information Questionnaire were used in this survey. An informed consent was attached on the first page of questionnaire, and then the informed consents were obtained from all participants. We emphasized maintaining anonymity and confidentiality, assuring participants' right to withdraw at any time without responsibility. A user identification number was assigned to each participant to avoid repeated submission of the questionnaire. Researchers were responsible for quality control of collected data throughout the entire process of survey. To evaluate test-retest reliability, participants were invited to complete the questionnaire again 2 weeks later. Eventually, 30 kindergarten staff filled out the same scale again for the retest.

The survey questionnaire included the initial Health Literacy Scale with 34 items and the General Information Questionnaire. The Health Literacy Scale was scored by using a five-point Likert method. the items 1–11 were evaluated as 1 = "completely disagree", 2 = "disagree", 3 = "uncertain", 4 = "agree" to 5 = "completely agree"; items 12–34 were evaluated as: 1 = "never", 2 = "rarely", 3 = "sometimes", 4 = "often" to 5 = "almost always". Items 12–14 were reverse-scored. The total score was determined by summing the score for each item, while a higher score indicated greater health literacy. Data on demographics were also collected from the participants by using the General Information Questionnaire, which included age, gender, educational background,

occupation, institutional place, years of work, first aid experience, and health-related courses or training received.

Statistical analysis

IBM SPSS v.25.0 software and Amos v.24.0 software were used for analyses. The descriptive statistics were calculated for the demographic data by using frequencies and proportions.

Item analysis was used to test the appropriateness or reliability of the individual item in the scale [37]. It was conducted by using critical ration, item-total correlation analysis, and Cronbach's alpha if item deleted. For the critical ration, the sample was divided into a high-score group (the top 27% of the highest scoring) and a low-score group (the lower 27% of the lowest scoring) according to the total score of participants. Then the mean score of each item in the two groups was compared by using an independent samples *t-test* to test the difference between the two groups, and the critical ratio of the item was obtained.

Content validity was measured to verify the consistency between the items, and identify whether the contents can measure the defined objective. The item content validity index (I-CVI) and scale-content validity index (S-CVI) were measured, and both the I-CVI value and S-CVI value of more than 0.78 and 0.90 were considered to be acceptable respectively [38].

Structural validity refers to the degree of agreement between the structure of the scale being tested and the theoretical structure. An exploratory factor analysis (EFA) was conducted by using principal component analysis with oblique rotation. Items were deemed to be relevant if extracted factors achieved an eigenvalue ≥ 1.0 and the factor loading value exceeded more than 0.40 [39]. The appropriate sampling size for factorization was assessed by administering the Kaiser Meyer Olkin test (KMO), and a value above 0.50 indicates an acceptable sample size for reliable results [40]. The criteria of initial item retention and deletion included the following aspects: (a) retaining items with a factor loading >0.4 (indicating fair) for capturing the facets of measure concept which this scale has covered; (b) removing cross-loaded items with a loading >0.4 on two or more factors [41]; (c) reviewing and comparing items with the provisional attributes and elements found through the literature review, and deleting items after reaching the consensus of all researchers. A confirmatory factor analysis (CFA) was performed based on the model selected from the EFA. The fitness of the model was examined by using the following series of indices: chi-square/degrees of freedom (χ^2/df) value of less than 3, root mean square residual (RMR) of less than 0.05, root mean square error of approximation (RMSEA) of less than 0.08, the goodness of fit index (GFI), comparative fit index (CFI), normed fit index (NFI), incremental fit index (IFI), and Tucker–Lewis index (TLI) of greater than 0.90 [42]. However, it was also suggested that GFI with a value of 0.8 or greater could indicate a reasonable model fit [43, 44]. Modification Indices (MI) were used to identify highly related items.

Reliability refers to the consistency and stability of the results produced by the instrument. Cronbach's α coefficient was used to assess the internal reliability of the scale, and a value of more than 0.7 was considered to be satisfactory [45]. For split-half reliability, the correlation coefficient was computed based on scores obtained by participants on two halves of the items, and a value of ≥ 0.7 was acceptable. To determine stability after the intervals between testing and retesting, the intraclass correlation coefficient (ICC) was computed. The ICC values of 0.60 to 0.80 were deemed to be good reliability, and ICC values above 0.80 were regarded to be excellent reliability [46].

Convergent validity was confirmed through standardized regression weight (SRW) [47], composite reliability (CR), and average variance extracted estimate (AVE) [48] and each factor was consistently and accurately measured. There was no criterion (i.e., "gold standard") validity for the health literacy of kindergarten staff. Discriminative validity was estimated based on the assessment of inter-group differences. A comparative analysis of groups of kindergarten staff was performed. Independent samples t-test and one-way analysis of variance were used to make a comparison among different groups.

Results

Sample characteristics

482 kindergarten staff were invited to complete the questionnaire, 471 questionnaires were returned. A total of 466 questionnaires were deemed to be valid and were included in the analysis. The response rate was 96.7%. Participants had a mean age of 31.90 years (SD = 8.92). Most of them were women (96.35%), and most of them were preschool teachers (85.19%). Nearly half of them had a bachelor's degree or above (41.85%). Nearly three-quarters of them worked in public kindergartens (71.67%). Nearly one-fifth of them had been working for up to 15 years (14.38%). More than one-third of the participants had experience in providing first aid to preschool children (37.98%).

Content validity analysis

Fifteen experts, who participated in the consultation, comprised of five child health and nursing specialists, one preschool educationist, four nursing education specialists, three clinical nursers, one psychologist and one nutritionist. The response rate was 100%. The mean age

of experts was 47.07 years (SD = 3.65). All of them have a Master's degree or above and they have been working in their specific field for more than 10 years at an average of 23.07 years (SD = 5.44).

The expert judging basis coefficient (Ca) and familiarity coefficient (Cs) were 0.927 and 0.847 respectively. The expert authority coefficient (Cr) was 0.887. Based on experts' suggestions, the items were revised after group discussions, six items acknowledged to be inappropriate or semantically similar were removed or merged, five items were added, eleven items were modified to avoid ambiguity, ensuring them to be consistent with the defined concepts. The order of the scale items was adjusted. The consistency judgment coefficient (Kendall's W) of the experts was 0.201 ($P<0.001$). The scale showed good content validity, and the value of S-CVI was 0.924, and the value of I-CVI ranged from 0.83 to 1.00. Then, 34 items were identified for survey after being reviewed by experts.

Item analysis

Table 1 presents the item analysis results for a total of 34 items. An additional file shows the specific contents of these items [see Additional File S1]. The results indicated that the critical ratio of each item was above the judgment criterion (>3.0). The statistically significant difference in the scores of each item between high-score group and low-score group ($P<0.001$) indicated that each item had good discrimination without the floor or ceiling effect. The item-total correlation was observed to be in the range of 0.217 to 0.783 ($P<0.01$), and a correlation value of less than 0.2 was used as the cut-off value below which an item should be considered to be redundant [49]. The Cronbach's α of the overall scale was 0.944. The Cronbach's alpha values above 0.944 were obtained for Items 12–14. These 3 items were used to measure the literacy skills in writing, reading and numeracy that cannot be covered by other items. These three items were remained for further analysis at the discretion of the researchers. No items were deleted after item analysis.

Construct validity analysis

The total data ($n=466$) were randomly split into two groups using SPSS 25.0. The EFA was conducted with 190 samples by using principal components analysis with oblique rotation to account for the relationship among the factors. The CFA was conducted with 276 samples based on the model selected from the EFA.

Exploratory factor analysis

EFA was conducted by using principal components extraction for testing the construct validity of the scale. The correlation matrix showed ample adequacy of the sample size (the Kaiser-Meyer-Olkin measure was 0.922) and the Bartlett test results ($\chi^2=8575.696$, $P<0.001$) rejected the hypothesis of zero correlations. The scree plot indicated that there were four factors. In addition, based on Kaiser's criterion of extracting factors with eigenvalues of greater than 1, a four-factor structure (Factor 1 = 14.152, Factor 2 = 11.588, Factor 3 =2.923, Factor 4 = 10.124) that explained 77.364% of the variance of the data was identified by the pattern matrix.

Table 1 The results of item analysis ($n=466$)

Items	Critical ration	Correlation coefficient with the total score of scale	Cronbach's α if item deleted	Items	Critical ration	Correlation coefficient with the total score of scale	Cronbach's α if item deleted
A1	12.750**	0.597**	0.944	B18	14.229**	0.701**	0.941
A2	13.227**	0.595**	0.944	B19	13.813**	0.712**	0.941
A3	14.284**	0.606**	0.944	B20	13.976**	0.715**	0.941
A4	14.249**	0.626**	0.944	B21	16.549**	0.771**	0.941
A5	15.861**	0.651**	0.944	B22	17.529**	0.783**	0.940
A6	14.889**	0.650**	0.943	B23	15.372**	0.747**	0.940
A7	14.187**	0.611**	0.943	B24	14.354**	0.731**	0.941
A8	15.039**	0.632**	0.943	B25	14.611**	0.738**	0.941
A9	15.212**	0.640**	0.943	C26	16.898**	0.744**	0.941
A10	15.385**	0.635**	0.943	C27	16.208**	0.752**	0.941
A11	16.069**	0.654**	0.943	C28	15.523**	0.758**	0.941
A12#	5.306**	0.217**	0.948	C29	15.131**	0.703**	0.941
A13#	6.483**	0.269**	0.948	C30	16.423**	0.736**	0.941
A14#	7.941**	0.309**	0.949	C31	15.533**	0.741**	0.941
B15	7.981**	0.474**	0.944	C32	16.379**	0.737**	0.941
B16	12.944**	0.682**	0.941	C33	11.554**	0.606**	0.943
B17	13.810**	0.695**	0.941	C34	17.799**	0.767**	0.941

Note. A, B, and C represent the domains of Functional, Communicative, and Critical health literacy in the initial scale respectively. #: Reverse scoring item. **: $P<0.01$.

Factor 1 was comprised of 14 items (items 26–34 and items 21–25). Factor 2 was comprised of 11 items (items 1–11). Factor 3 was comprised of 3 items (items 12–14). Factor 4 was comprised of 5 items (items 16–20). Item 15 was removed because the factor loading produced was lower than 0.40. Item 23 was removed due to serious cross-loading, it was simultaneously loaded on Factor 1 (loading value=0.421) and Factor 4 (loading value=0.445). Items 21–22, and Items 24–25 in Communicative Health Literacy were loaded on Factor 1 (which mainly included the items related to critical health literacy). These four items were removed because they could not integrate into any factor, suggesting that they were limited in measuring the key construct of communicative health literacy. It was difficult to generalize these items as a separate dimension, which might result in the final model being inconsistent with the theoretical framework in this research.

Table 2 Factor loading on items of the scale ($n=190$)

Items	Factor 1	Factor 2	Factor 3	Factor 4	Communality variance
C30	0.951				0.840
C29	0.920				0.798
C27	0.845				0.791
C26	0.832				0.800
C28	0.831				0.786
C34	0.824				0.830
C32	0.808				0.826
C31	0.767				0.829
C33	0.743				0.496
A8				0.964	0.853
A9				0.916	0.788
A6				0.916	0.816
A4				0.882	0.788
A7				0.873	0.813
A1				0.872	0.713
A11				0.856	0.820
A10				0.841	0.796
A3				0.835	0.707
A2				0.809	0.704
A5				0.717	0.626
A13			0.922		0.847
A14			0.905		0.844
A12			0.853		0.730
B19		0.994			0.968
B18		0.970			0.949
B17		0.963			0.936
B20		0.959			0.960
B16		0.805			0.772
Eigenvalues	13.079	5.377	2.167	1.803	
Variance(%)	46.712	19.205	7.737	6.438	
Cumulative(%)	46.712	65.917	73.654	80.092	

Note. A, B and C represent the domains of Functional, Communicative, and Critical health literacy in the initial scale respectively.

The remaining 28 items were subjected to EFA. The principal component analysis with 28 items revealed four factors with eigenvalues exceeding 1.0 and a total variance of 80.092%. Combined with the results of the scree plot, Kaiser Criterion (eigenvalue) and the meaningfulness of factors, a four-factor structure was finally identified. Table 2 shows the results of factor loading on items. The factor loadings of items ranged from 0.717 to 0.994. The communality value of each item was above 0.496, which was higher than the acceptable value of 0.40 [50]. Correlation analysis showed a weak correlation between extracted factors (factor intercorrelations ranged from 0.007 to 0.577), indicating the suitability of an oblique rotation solution. These 28 items are attached in an additional file [see Additional File S1].

The characteristics of the four factors in the highest factor loading value order were identified, and a name that could encompass all the items within the factor was given based on the conceptual definition of health literacy in this research. Factor 1 was labeled as "critical health literacy", including nine items related to the critical thinking of health information and health-related decision-making. Factor 2 was labeled as "communicative health literacy", including five items related to providing health education for preschool children. In Factor 3, three items were loaded as "functional health literacy skills" including fundamental skills in writing, reading and numeracy to obtain the relevant health information and apply that information to a limited range of prescribed activities. Similarly, in Factor 4, eleven items were loaded as "basic health knowledge" related to the knowledge about disease prevention, and healthy development of preschool children.

Confirmatory factor analysis

A total of 276 samples were used to perform CFA. A four-factor model was established according to the results of EFA. The fit indexes were excellent in the modified model (see Figure 2). The results showed that RMSEA was 0.063, less than 0.08; RMR was 0.031, less than 0.05; GFI was 0.852 indicating a reasonable fit, NFI and IFI were 0.923 and 0.958 exceeding the benchmark of 0.90, being complied with the suggested parameters for satisfactory model fitting. Four-factor model was testified to be perfectly fit the survey data (see Table 3).

Convergent validity and discriminant validity analysis

The results of the convergent validity analysis showed that the standardized regression weight of the standardized factor loading values ranged from 0.649 to 0.981. All the critical ratio were above 10.504, being significant (>1.965). The CR values ranged from 0.880 to 0.975 and the AVE ranged values from 0.639 to 0.888, which met the standard value. (See Table 4).

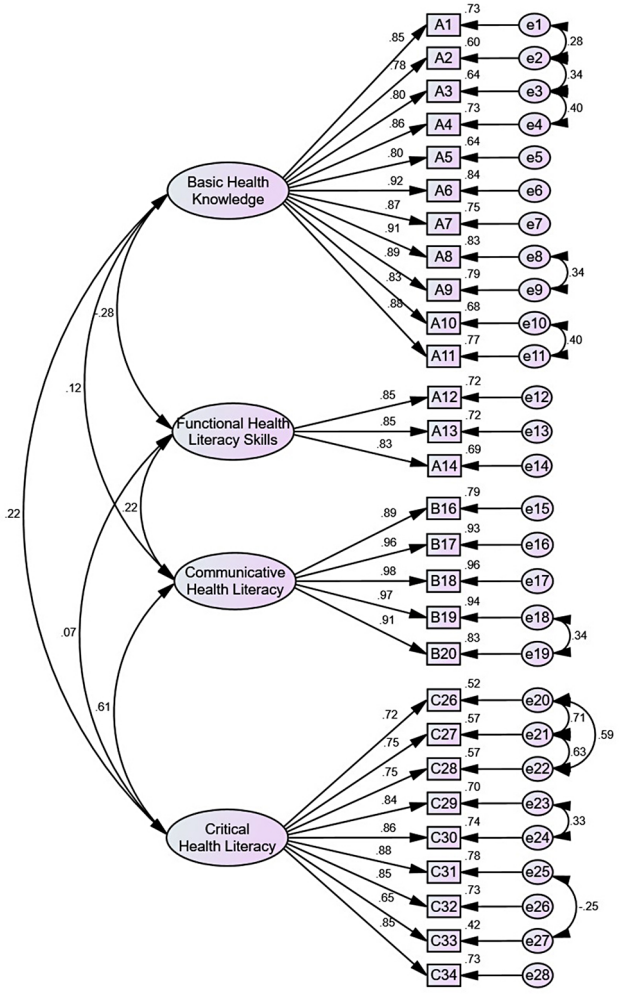

Fig. 2 A schematic diagram of standardized model fitting of the scale ($n=276$)

Table 3 The fitting indexes of confirmatory factor analysis of the scale ($n=276$)

Index	Benchmark	Initial model	Modified model
χ^2/df	< 3	3.552	2.093
GFI	> 0.80	0.743	0.852
CFI	> 0.90	0.899	0.958
RMSEA	< 0.08	0.096	0.063
RMR	< 0.05	0.034	0.031
NFI	> 0.90	0.866	0.923
IFI	> 0.90	0.900	0.958
TLI	> 0.90	0.889	0.953
PCFI	> 0.50	0.819	0.844

The discriminate validity was confirmed by its ability to detect the significant differences among subgroups known to vary in the scores. The results demonstrated that participants who had higher educational levels were found to be significantly associated with higher scores in health literacy. Moreover, the participants who had first aid experience for preschool children acquired a high score of health literacy (see Table 5).

The reliability analysis

The Cronbach's alpha for the overall scale was 0.921 and the four dimensions had the Cronbach's alpha of 0.967 (Basic Health Knowledge), 0.879 (Functional Health Literacy Skills), 0.976 (Communicative Health Literacy), and 0.947 (Critical Health Literacy). Split-half reliability was 0.805 for the entire scale, and values for the four dimensions ranged from 0.883 to 0.972. Test-retest reliability by the ICC test was 0.885 [95% confidence interval 0.773–0.944; $P<0.001$] for the overall scale and 0.735 to 0.963 for the four dimensions ($P<0.001$).

Discussion

The conceptual framework of health literacy proposed by Nutbeam could clearly illustrate the connotation of health literacy and laid a theoretical foundation for the scale development in this research. The final 28-item Health Literacy Scale encompassed four dimensions: Basic Health Knowledge (11 items), Functional Health Literacy Skills (3 items), Communicative Health Literacy (5 items) and Critical Health Literacy (9 items). It covered a range of issues relevant to healthcare of children aged 3–6 years in kindergarten setting, making it suitable for measuring health literacy of staff in kindergarten.

EFA and CFA were used to evaluate the construct validity of the scale. Four common factors were produced through EFA, and the cumulative variance contribution rate was 80.092%. CFA was tested to explore the fit of the four factors in EFA. The fixed fit cutoffs widely adopted in empirical research were adopted to identify potential model misspecification in this research, which would contribute to selecting a concise model. Examining several qualitative indices with well-established properties is typically recommended to evaluate model fit [51]. Except for the possible small sample size effect, the values of seven indices including χ^2/df, RMSEA, RMR, GFI, CFI, NFI, IFI, TLI, and PCFI were suitable, indicating that the model of the four-factor structure had an acceptable fit. These findings indicated that the four-factor structure fitted well with the default model. Some correlated errors were modified in the final model, which might be due to certain correlations between items. Since the scale has been designed based on the conceptual definition of health literacy, it would be difficult to conclude that there was no correlation between the elements within the concept [52].

The CVI was adopted as the main method to quantify content validity for multi-item instruments. The results showed that the I-CVI values were higher than 0.78 and the S-CVI value was higher than 0.90, indicating that the content validity of the scale was reliable.

Table 4 The results of convergent validity ($n=276$)

	Regression weights estimate	SRW (criteria>0.5)	Critical ratio (criteria>1.965)	*P*-value	CR (criteria>0.7)	AVE (criteria>0.5)
A1←F4	1.000	0.854			0.967	0.728
A2←F4	1.014	0.775	18.719	<0.001		
A3←F4	1.065	0.803	16.875	<0.001		
A4←F4	1.104	0.857	18.945	<0.001		
A5←F4	1.108	0.799	16.750	<0.001		
A6←F4	1.113	0.916	21.553	<0.001		
A7←F4	1.076	0.868	19.401	<0.001		
A8←F4	1.081	0.909	21.189	<0.001		
A9←F4	1.051	0.887	20.190	<0.001		
A10←F4	1.097	0.827	17.737	<0.001		
A11←F4	1.097	0.879	19.856	<0.001		
A12←F3	1.000	0.848			0.880	0.710
A13←F3	1.005	0.851	15.809	<0.001		
A14←F3	1.007	0.828	15.449	<0.001		
B16←F2	1.000	0.887			0.975	0.888
B17←F2	1.068	0.962	27.703	<0.001		
B18←F2	1.077	0.981	29.436	<0.001		
B19←F2	1.064	0.968	28.205	<0.001		
B20←F2	0.956	0.909	23.655	<0.001		
C26←F1	1.000	0.721			0.940	0.639
C27←F1	1.033	0.753	22.794	<0.001		
C28←F1	0.992	0.752	19.327	<0.001		
C29←F1	1.151	0.836	13.709	<0.001		
C30←F1	1.210	0.863	14.182	<0.001		
C31←F1	1.169	0.883	14.493	<0.001		
C32←F1	1.210	0.853	14.028	<0.001		
C33←F1	1.210	0.649	10.504	<0.001		
C34←F1	1.264	0.853	14.030	<0.001		

Note: A, B, and C represent the domains of Functional, Communicative, and Critical health literacy in the initial scale respectively; F=Factor; SRW=Standardized regression weight; CR=Composite reliability; AVE=Average variance extracted estimate.

The results showed that the Cronbach's α coefficient for the overall score was 0.921 and dimension score ranged between 0.879 and 0.976, indicating that the internal consistency of the scale was confirmed to be good. The test-retest reliability coefficient for the overall score was 0.885, indicating strong reliability. The ICC values of the overall score and each dimension were found to be optimal. These findings indicated that the scale had excellent reliability.

The determination of three items in the dimension of "Functional Health Literacy Skills" was primarily based on the following considerations. Firstly, these items were generated by a combination with literature references and kindergarten work. The importance of basic skills in reading, writing and numeracy has been addressed in the conceptual model of health literacy proposed by Nutbeam [34]. This model begins with an assessment of prior understanding of individual capacity (reading, writing, numeracy, and existing knowledge), which can support greater empowerment in health decision-making. It is necessary and important for kindergarten staff to master the basic skills of writing, reading and numeracy, which can help them to obtain health information, and participate more fully in the healthcare activities created for preschool children; Secondly, all of 15 experts agreed that the items regarding functional health literacy skills were important; Thirdly, the result of EFA indicated that a dimension constituted by these 3 items in a four-factor structure was acceptable. According to the relevant literature [32, 53, 54], three items are sufficient to constitute a dimension. The results of CFA further confirmed that four-factor structure was an ideal model. Therefore, these 3 items were retained, which made a distinction between literacy skills and knowledge. This structure was consistent with the assessment tool designed by Chung-liang Shih [55], and his Functional Health Literacy includes two constructs, namely, basic health knowledge and functional literacy.

In developing instruments to assess health literacy in different groups, the relevant studies have focused on different domains of health literacy [56–59]. For example, the interactive health literacy was identified

Table 5 Demographic characteristics of institutional staff in kindergartens ($n=466$)

Variable		*n* (%)	Total score	F/t	*P*
Gender	Male	17 (3.65)	117.12 ± 13.21	-0.332	0.740
	Female	449 (96.35)	118.39 ± 15.59		
Age(years)	18 ~ 25	140 (30.04)	116.15 ± 16.33	2.235	0.039*
	26 ~ 30	92 (19.74)	120.73 ± 13.95		
	31 ~ 35	103 (22.10)	117.26 ± 15.85		
	36 ~ 40	42 (9.02)	114.98 ± 16.39		
	41 ~ 45	39 (8.37)	122.56 ± 15.88		
	46 ~ 50	29 (6.22)	122.79 ± 12.75		
	>50	21 (4.51)	120.62 ± 12.25		
Marital status	Married	262 (56.22)	118.53 ± 15.61	0.286	0.775
	Unmarried	204 (43.78)	118.11 ± 15.39		
Years of work	≤ 15	399 (85.62)	117.75 ± 15.66	-2.179	0.032*
	>15	67 (14.38)	121.88 ± 14.12		
Occupation	Healthcare personnel	8 (1.72)	117.38 ± 13.68	4.479	0.001**
	Caregiver #	35 (7.51)	111.31 ± 17.59		
	Part-time Teacher #	24 (5.15)	108.21 ± 17.10		
	Preschool Teacher	373 (80.04)	119.53 ± 14.94		
	Kindergarten principal	19 (4.08)	122.63 ± 14.31		
	Another #	7 (1.50)	114.43 ± 14.70		
Education	Beyond Junior High School	61 (13.09)	110.11 ± 17.02	11.215	<0.001
	Junior College	210 (45.06)	118.62 ± 15.61		
	Undergraduate and above	195 (41.85)	120.63 ± 14.04		
Location	City	288 (61.80)	118.18 ± 15.48	0.082	0.775
	Town	117 (25.11)	118.22 ± 15.44		
	Rural	61 (13.09)	119.34 ± 15.91		
Institutional nature	Public	334 (71.67)	120.05 ± 14.63	3.617	<0.001
	Private	132 (28.33)	114.02 ± 16.80		
Have experience in first aid for preschool	Yes	177 (37.98)	120.30 ± 15.86	2.138	0.033*
	No	289 (62.02)	117.15 ± 15.18		

Note. # Caregiver also called "childcare workers" who provide care for children in kindergarten.

Part-time teacher is the person who simultaneously works as a preschool teacher and caregiver.

Another refers to intern and administrators.

* represents $P<0.05$; ** represents $P<0.01$.

to be more important to those patients with chronic disease [60], and the targeted health skills have been designed in the functional health literacy domain for people with special health needs [58]. As for kindergarten staff are concerned, health literacy can be seen as a method, which can reflect their ability to obtain health information, and make individuals exert greater control over health issues and determinants affecting children's health. Considering the important role of kindergarten staff in health behavior education and health decision-making, specific emphasis should be placed on the comprehensive measurement of health literacy. In this research, items about communicative and critical health literacy have been developed as a sign of competency in optimal health decision-making and providing health behavior education for preschool-age groups. According to Nutbeam, the development of health literacy skills is interdependent. Each level is built on and incorporated into the skills from previous level [10]. In developing health literacy skills, an individual generally progresses from the basic level to the advanced level [61, 62]. There lies a certain hierarchical relationship between key constructs of health literacy. This means that it is through developing the basic skills that kindergarten staff can further develop the advanced skills related to communicative and critical health literacy.

This research has several strengths. The Health Literacy Scale is designed to differentiate between high health literacy and low health literacy. A higher score indicates greater health literacy. The items of scale are scored by using a five-point Likert method. Words like frequency (almost, always, often, sometimes, rarely, and never) are used in the dimensions of Functional Health Literacy Skills, Communicative Health Literacy and Critical Health Literacy, which can better evaluate the frequency and awareness of kindergarten staff in using the relevant health literacy skills to acquire, analyze and apply health information. Through this way, we can detect the

potential difficulties or needs from kindergarten staff while they are accessing and applying health information. Moreover, the improvement of health literacy is realized not only through strengthening individual skills and abilities but also depending on comprehensive promotion from the healthcare system [63]. For healthcare researchers, this scale is conducive to understanding the level in different health literacy dimensions among kindergarten staff. Depending on the differences in health literacy scores, they can develop targeted interventions and training to narrow the gap in health literacy between different groups of kindergarten staff (e.g., public vs. private), which will encourage maximum health literacy and health education in the subsequent research.

The previous research showed that demographic, cultural factors and prior experience in health education were the antecedents of health literacy [11]. This point of view was confirmed in this research, for which the score of health literacy appeared different in age, education, occupation, seniority, institutional nature, and experience of first aid. It verified that the Health Literacy Scale for staff in preschool childcare institution could detect the heterogeneity of different populations. Future research could explore the relationship between the health literacy of institutional staff and children's health outcomes, providing the evidence for emphasizing the importance of institutional staff's health literacy in preschool childcare environment. The fact is that presently more females are dedicating themselves to the field of preschool care and education and that is why more females are recruited in this research than males. This is a phenomenon worth the researchers' attention. The health literacy of groups with different gender and work experience in childcare are worth further investigation in the future.

Limitations

Despite the results of validity and reliability being satisfied, several limitations should be acknowledged. Firstly, the participants were recruited by using convenience sampling, which would result in selection bias. It might affect the generalization and application of the scale to some degree. However, the survey in this research covered kindergartens of different areas, and kindergarten staff of different ages, education level, occupations, and years of work, suggesting that the scale was understandable and acceptable to most of kindergarten staff. A large sample research involving multiple centers should be further conducted to explore the standardization of different levels, which could better inform the user of the scale. Secondly, in analyzing the data, criterion validity was not directly determined because a gold standard does not exist in practice, and psychometric properties should be further verified in future validation research. Thirdly, some correlated errors modified in the final model were theoretically underpinned, and there might remain the possibility that the correlated errors reflected the effectiveness of the method rather than other potential constructs within the identified factors [64]. It was confirmed that a four-factor structure was ideal in this research. Lastly, this scale was designed to evaluate the health literacy of staff in preschool childcare institutions, particularly focusing on the abilities required for their daily interactions with preschool children. In designing the scale, we mainly focused on the knowledge and skills related to childcare that staff need in the kindergarten environment. While family issues are certainly important, they are broad and complex, necessitating a more thorough exploration and professional intervention. In future research, we would like to further investigate the relationship between family issues and children's psychological and behavioral development, and explore how to incorporate these factors into the scale.

Conclusion

The Health Literacy Scale which focuses on health issues of children aged 3–6 years has been developed for staff in preschool childcare institutions. It is a five-point Likert scale consisting of 28 items with four dimensions. A higher score indicates a greater health literacy level. This scale can be used not only to evaluate the relevant health literacy level, but also to guide researchers in planning and providing customized health education or interventions for improving the health literacy of staff in preschool childcare institutions.

Abbreviations

SPSS	Statistical Package for the Social Sciences
AMOS	Analysis of Moment Structure
EFA	Exploratory Factor Analysis
CFA	Confirmatory Factor Analysis
SD	Standard Deviation
CVI	Content Validity Index
I-CVI	Item-Content Validity Index
S-CVI	Scale-Content Validity Index
KMO	Kaiser Meyer Olkin Test
RMR	Root Mean Square Residual
RMSEA	Root Mean Squared Error of Approximation
GFI	Goodness of Fit Index
CFI	Comparative Fit Index
NFI	Normed Fit Index
IFI	Incremental Fit Index
TLI	Tucker-Lewis Index
PCFI	Parsimonious Comparative Fit Index
MI	Modification Indices
ICC	Intraclass Correlation Coefficient
SRW	Standardized Regression Weight
CR	Composite Reliability
AVE	Average Variance Extracted

Supplementary Information

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Supplementary Material 1: Additional File 1 The Health Literacy Scale for staff in preschool childcare institution (pdf). An additional file enclosed

shows the 34 items for the cross-sectional survey and the final 28-item Health Literacy Scale for staff in preschool childcare institution.

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Author contributions
XZ, YJ and YP Z finished the conceptualization; XZ, YJ, TC and YP Z finished the methodology; XZ, GM and LH finished investigation; XZ and JZ finished formal analysis; XZ finished original writing, draft preparation; YJ and TC finished review and editing. All authors contributed to redrafting and approving the final version of manuscript.

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Data availability
The authors confirm that the datasets supporting the conclusions of this article are included within the article and its additional file.

Declarations

Ethics approval and consent to participate
This research complies with the Declaration of Helsinki. The studies involving human participants were reviewed and approved by the Ethics Committees of Xi'an Jiaotong University (number: 2021 – 1511). Participants were engaged in and contributed to the validation of the Health Literacy Scale for staff in preschool childcare institution. Informed consents were obtained from all participants before participating in the study.

Consent for publication
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Competing interests
The authors declare no competing interests.

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